UNITED STATES DEPARTMENT OF AGRICULTURE
FLOOD CONTROL ADVISORY COMMITTEE
Washington

February 15, 1940.

MEMORANDUM NO. 61

MEMORANDUM FOR FIELD FLOOD CONTROL COMMITTEES
(Through BAE, FS, and SCS)

Subject: Policy on Relative Survey Intensity Within Watersheds Approved for Survey.

Past survey instructions have indicated the desirability of delineation of watersheds approved for survey into flood and silt source areas on the basis of their contribution to the flood problem. (Relative contribution in terms of run-off, flood flow, erosion, silt, and damages, etc.) It is recognized, of course, that in case of many watersheds the entire basin contributes more or less uniformly to the flood problem. In other watersheds sharp differences may be found.

The question has arisen as to the intensity of survey on areas shown to be of minor importance as flood contributors by hydrologic and other studies. This memorandum is intended to provide a general guide to the survey personnel in answering this question.

After the flood and silt source areas are delineated and their relative contributions to the flood problem determined, the following general procedure should be followed:

(1) If an area is found to be a major contributor or a significant contributor to the flood problem, proceed with an investigation of the area to determine if there are feasible and economically justifiable remedial measures, and if so, to prepare general area plans for such measures including estimates of extent of such measures, cost distribution, and types and amounts of benefits.

(2) For areas in a watershed approved for survey which are not now but may become significant contributors to flood problems because of land use changes or conditions underway or probable, the physical effects of the changes if made, should be estimated as well as the nature and probable cost of a preventive program. If the estimated physical effects appear to be significant an approximation of the cost-benefit ratio should be made. A complete cost-benefit analysis probably should not be undertaken for such areas.

(3) For areas in watersheds approved for survey which are not important present or potential contributors to the flood problem, the survey should go only far enough to confirm that fact to a reasonable degree, and to make general recommendations for a program which

appears to be desirable and feasible for land use and protection. These recommendations can be made on the basis of present information and limited observation and study without detailed investigation. The costs and benefits of such recommendations need not be estimated.

The report should cover the whole watershed approved for survey unless authorization is given for unit reports; however, the main part of the report should be devoted to the major or significant areas contributing to the flood problem, with only brief coverage given to the remaining areas.

E. H. Wiecking

E. H. Wiecking,
Associate Land Use Coordinator,
In Charge, Flood Control Coordination.

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
Office of Land Use Coordination
Washington

February 16, 1940.

MEMORANDUM NO. 62

MEMORANDUM FOR FIELD FLOOD CONTROL COMMITTEES
(Through BAE, FS, and SCS)

Subject: Transmittal of Proceedings of Seminar on Aerial Photography

The seminar on aerial photography held December 6 - 8, 1939 provided the opportunity for the exchange of observations and ideas growing out of the experience of survey personnel with aerial photographs. The seminar was also fruitful in clearing up numerous questions and misconceptions concerning limitations of photographs of different scales and types, the transfer of information to base maps, and the value of various makes of stereoscopes.

Although confined to the eastern survey groups, the discussions and conclusions reached at the meetings are generally applicable throughout the country.

It is believed that careful reading of the proceedings will reveal opportunities for reducing survey costs, will stimulate further thought in this young field and lead to further developments in the application of aerial photographic techniques.

E. H. Wiecking

E. H. Wiecking,
Associate Land Use Coordinator,
In Charge, Flood Control Coordination.

Attachment

PROCEEDINGS OF

SEMINAR ON

AERIAL PHOTOGRAPHY IN FLOOD CONTROL SURVEYS

December 6 - 8, 1939.

Flood Control Advisory Committee
U. S. Department of Agriculture
Washington, D. C.

ATTENDANCE RECORD

Air Photo Seminar

Name	Bureau	Office or Project
Herb Denler	BAE	Div. State & Local Planning
O. L. Mimms	BAE	Wash.Office (Late from Boise)
Lilburn Allen	SCS	Muskingum Survey
Jesse H. Zabriskie	SCS	Trinity Survey
Edwin R. Kinnear	SCS	Washington, D. C.
A. M. O'Neal	SCS	Washington, D. C.
N. A. Back	BAE	Potomac Survey
John W. Roehl	SCS	Susquehanna Survey
C. M. McEwan	BAE	N. E. Regional Office
H. H. Wooten	BAE	Washington, D. C.
M. S. Wright	TAB	Washington, D. C.
M. M. Lehrbas	FS	Yazoo Survey
H. B. Ingersoll	SCS	Pee Dee Survey
Milton M. Bryan	FS	Pee Dee Survey
Robert D. Williams	FS	Potomac Survey
Robert Terry	BAE	Potomac Survey
R. C. Wilson	FS	Berkeley, California
Lawrence E. Kindt	BAE	Washington, D. C.
E. S. Massie, Jr.	FS	Washington, D. C.
Earl J. Rogers	FS	Philadelphia, Pa.
Louis A. Woodward	SCS	Washington, D. C.
J. E. Rothery	FS	Washington, D. C.
W. B. Carmody	AAA	Washington, D. C.
Lyall E. Peterson	FS	Washington, D. C.
Gordon R. Salmond	FS	Washington, D. C.
Claude E. Haren	BAE	Washington, D. C.
F. J. Marschner	BAE	Washington, D. C.
A. M. Meyers, Jr.	BAE	Washington, D. C.
Richard A. Hertzler	FS	Washington, D. C.
R. H. Davis	SCS	Washington, D. C.
Bernard Frank	FS	Washington, D. C.

SEMINAR ON

APPLICATION OF AERIAL PHOTOGRAPHY IN U.S.D.A. FLOOD CONTROL SURVEYS

Washington, D. C. December 6-8, 1939.

The seminar was held in accordance with the intent of Flood Control Coordinating Committee Memorandum No. 41, Use of Aerial Photographs on Surveys, of April 27, 1939 to field members of the flood control organization. Messrs. Wright, Snyder, Moyer, Massie and Woodward contributed materially to the preparation of the agenda and made many helpful suggestions during their participation in the meetings. Special acknowledgment is due Messrs. Moyer and Woodward in arranging the visits to the photographic laboratories of the AAA and SCS respectively.

Through the courtesy of the Fairchild Aerial Camera Corporation, the Abrams Aerial Survey Corporation, Inc., Standard Aerial Surveys, Inc., and the Navy Department, the following stereoscopic equipment was made available for inspection by the group:

Mirror Stereoscopes

Model T-5 Tele-stereoscope
Model T-4 Tele-stereoscope
Model 5 Smith type folding stereoscope
Folding pocket type mirror stereoscope
Stereocomparagraph (sketching stereoscope)
M-7 Mirror stereoscope
Note: None of the above have any magnification
Abrams Contour Finder (magnifying)

Zeiss magnifying stereoscope and stereometer bar (with binocular attachment)

Direct Vision Stereoscopes

D-10 Standard stereoscope (approximate magnification 1.4 diameters).

D-10 Hi-power (approximate magnification 3.6 diameters).

Ground glass stereoscope prepared on specification (approximate magnification 2 diameters)

Arrangements for the seminar were handled for the Flood Control Coordinating Committee by Messrs. Frank, Forest Service; Davis, Soil Conservation Service; and Wooten, Bureau of Agricultural Economics. Mr. Frank acted as Chairman.

(Over)

Frank - The Flood Control Survey program has been underway approximately 1 1/2 years. During that time we have delivered quite a few aerial photographs. Some surveys have been handicapped because no pictures were available. In other cases contact prints, though available, have not been used effectively as a means of reducing field work. Nevertheless we have already been able to develop some knowledge of the use of these pictures. The Flood Control Coordinating Committee Memorandum 41 was to find out how much and what kind of use was actually being made of aerial photographs.

"Present standards and extent of use of air photographs already in the hands of field parties vary considerably. In several instances survey personnel with the aid of such stereoscopic equipment as is now available are getting surprisingly good results in identifying cover, soil and erosion, and flood plain conditions. This applies to the classification and study of broad problem areas as well as expediting the more detailed study of sample areas.

"In other instances the photographs are being used merely as "maps". However helpful this may be it fails by a considerable margin to realize on the far greater benefits that effective stereoscopic analysis can produce. The fact that aerial photographs are made to overlap indicates definitely that they are intended to be utilized stereoscopically in preference to the unaided eye.

"The Committee is therefore taking steps at this time to examine the possibilities of utilizing or developing types of stereoscopic equipment and techniques that will meet most effectively the needs of the flood control surveys."

Aerial photography and the methods of applying photos stereoscopically and otherwise have developed in response to very definite needs in surveying and mapping relief, culture and natural features rapidly, accurately and at low cost.

Topographers especially have been quick to recognize the value of aerial photographs and as a result their use has expanded manifold in the mapping of large and small areas. Also a glance at the growing literature indicates a wide variety of uses in addition to map making. These uses are increasing with improvements in the quality of photography and of stereoscopic equipment.

The flood control surveys provide an unusual opportunity to apply air photo techniques to a wide variety of purposes. Each survey represents in greater or less degree, the fields of Hydraulic and Civil Engineering, Geology, Soils, Forestry, Ecology, Range Management, Agronomy, Land Economics, etc.

No other type of survey demands closer integration on the ground of these techniques. The conduct of damage appraisal in flood plains requires the services of the sedimentation specialist, the land appraiser, the forester or range man, and the soils specialist. The classification of land by major physical and economic features is a process of synthesis requiring the services of many techniques. Study of flood and silt source areas undertaken as the basis for the preparation of remedial programs requires the close collaboration of all the techniques available to the survey.

Altogether these techniques and fields represent the scope of work of many programs of the U.S.D.A. In all of these types of investigations the information available from photographs of good quality and adequate scale is or can be made to be of the greatest possible value.

We hope that this meeting, devoted to the study of these questions will stimulate thinking on this subject and pave the way to a greater and more effective use of aerial photographs.

The meeting today will be devoted to description and discussion of the techniques now in use on the surveys and tomorrow morning these discussions will be concluded. Tomorrow afternoon we will visit the AAA and SCS laboratories. On Friday we will summarize the results of the first two days meetings by determining some of the more important problems, the methods of meeting them and also lay the ground work for the development of techniques that will be of help not only in flood control but in other Departmental activities.

We want to insure the fullest possible discussions by those who have been using photographs on flood surveys. Hence we have requested representatives of the several surveys present to describe the work they have been doing, its purpose, and its application. Ample time will be given to discussions and questions. As we are here to learn we hope you will make the most of this seminar.

Ingersoll - In covering the over-all work on the Coosa watershed we were fortified with quadrangle sheets which we do not have on the Pee Dee. There was no need for photogrammetric mapping except in the case of areas to be extended where we went to some trouble in making a few actual photogrammetric maps. The photos provided an accurate drainage outline of small tributaries.

Photographs were used: (1) to determine cover conditions on gaged tributaries for run-off evaluation; (2) to study damage areas for stage-damage relations using picture points to tie in with high water works; (3) to help delineate the critical areas. On the Pee Dee we will have a fourth use to fill in serious drainage pattern deficiencies in the small scale quad sheets available.

We took the contact prints and blocked out the effective portions of each and delineated broad land classes. Four conditions

were identified on each class: soil, cover, slope, and degree of erosion.

On the Coosa, we depended too much on photographs. We made every possible use of these photographs that we could. Some of the men objected to stereoscopic work because it was hard on the eyes. They also claimed they could not delineate certain features which we needed. This latter was overcome as the work progressed through field checks and practice.

Bryan - Ingersoll gave a good picture of the many uses to which we put our aerial photographs. On the Coosa, an area of 4,020 square miles, we first developed a sensible means of studying cover and land use. After some waste of time in attempting detailed land classification we developed a simple classification based on present cover, present land use and particularly land potentialities and capabilities. In applying land use classification to the pictures our land capability factor was used most frequently. We arrived at 29 different combinations or characteristics of land use. These were classed into the following major land uses:

1. Forest lands, - areas with 30% or more crown canopy.
2. Idle lands, - land of no economic value except for run-off control - broomsage lands, abandoned fields, etc.
3. Cultivated land, - all lands planted to crops.
4. Pasture land, - all grazing land other than pastured woodland.
5. Miscellaneous, - urban, railroads, public highways, etc.

These major classes were sub-divided by slope, soil, and erosion. Our soils men took photo index sheets in the field and made very broad soils delineations. We used standard SCS symbols and found about 200 soils in the watershed in which we are working. These were combined into 14 representative groups and then arranged in five large groups. We combined SCS erosion classification into six broad erosion groups. These were applied by the soils men in their field mapping. Symbols were then developed for transposition to contact prints on which through stereoscopic analysis the field mapping was adjusted and refined.

We worked up a card system which showed SCS erosion classes, SCS soils groups, and the flood control interpolations, finally ending up with a picture of present land use, land potentialities, and in addition recommended types of land treatment. This resulted in a purely mechanical classification reducing the element of personal bias.

As Ingersoll mentioned, we found that at first the individuals didn't like to use the stereoscopes. They claimed it was hard on the eyes, was slow work, and didn't reveal much information.

At first we attempted to study too small areas. Frank suggested a minimum of 15 acres for delineation. We put his method into effect and have thanked him ever since. Field checks indicate less than 5% error in interpolation.

Some of us had never seen aerial photographs and had never used stereoscopes. So we started a generalized training course. One man was put in charge of stereoscope analysis. He developed a detailed set of instructions. These instructions explained the use of photo-index sheets, methods of delineation, effective areas, average effective areas, distortion, etc.

A copy of these instructions is given as Appendix A.

This training period made individuals familiar with the methods. They worked on several pictures, field checked them, then returned to use the stereoscopes. This procedure was reviewed until each individual was proficient.

We worked 8,700 pictures hence needed a data recording system. For each county we developed a card summarizing the data by individual contact prints. We also separated upland delineations from flood plains. The data were then grouped from these summary cards and a table prepared covering all the data going into the final report. We also developed a card showing planted areas on one side and gullies on the other.

For area determination we used the celluloid grid developed by Lehrbas. Thus a CCC boy can take a grid, put it over a picture, and determine the acreages in need of gully control. We also used a dot system and found this modified grid accurate and much easier to use than the planimeter.

We had trouble keeping the pictures under the stereoscope but finally used metal slides to hold the photos and obtain proper focus. We found the reflecting mirror type of stereoscope best for over-all delineations but for detailed study the small direct vision stereoscope gave the best results. With these we got a wealth of data.

In preparing the generalized maps aerial mosaics were used first. Cover, use and erosion were outlined on tracing paper. The photos were then separated, reduced and the results were satisfactory accurate cover, erosion and soil maps.

Terry - Good use was made of the photos in flood damage appraisals in delineating the flood lines in the flood plains. By taking contact prints you can get from most farmers some high water marks of a specific flood. Holes are then punched through print and on the back useful information may be written. This work was done in cooperation with the Mobile District Corps of Engineers.

We also used contact prints in farm management studies. Boundaries for each farm were marked in red pencils, permitting field checks on individual farms. These were the major uses made of the pictures by BAE on the Coosa.

Discussion

Ingersoll - Damage work is very important. Mr. Lassen of the Army Engineers office in Mobile was responsible for working up methods for damage appraisal on which we collaborated. We sent two field men to work under the direction of that office. There were two field parties of three men each. Prints were used in the field. The Army also had quantities of records and notes of high water marks of the 1938 flood. We were able to locate high water marks with photographs by plane tables. Hand levels and picture point methods were used to locate flood contours. We took markings from 5 feet below and 5 feet above the 1938 flood. We thus obtained the bankfall stage, the '38 flood stage, and stages 5' above and below respectively. These data are now being worked up by the Army Engineers.

Actually the existing gage records were taken for each flood and a high stage established or taken from the records. The high stage was tied in and curves drawn to show season, date, etc. The BAE was then able to determine the stage-damage relation.

Bryan - We need better lighting and picture holders in stereoscopes.

Kinnear - Aerial projection as compared with other methods is probably more effective and quicker. The main objection is expense but lately this has been greatly reduced. The cost could be cut by pooling the equipment with several agencies.

Bryan - We liked the large reflecting mirror type of stereoscope for day by day work and got very satisfactory results. For detailed study, especially for gully depths, etc., we used the eyeglass type. In the T-5 (Fairchild) type, the lighting was found to be a little too much on one photo. How about the development of a table for stereoscopes together with proper lighting, and picture holders, to save time and ease eye strain?

Lehrbas - We developed a good stand and can make one in a few hours. I have a sketch here.

Back - How much time was used and how many acres were covered with the stereoscope per day?

Bryan - After a little experience Williams became efficient and covered 20 to 25 pictures in a day's time or 25 to 30 square miles. We used a man on stereoscopic work for two days and then sent him to the field for the third day. It is excellent procedure to have one man in charge of stereoscopes.

Frank - To what extent was your land classification modified by the economic studies?

Bryan - In a number of instances we took the pictures to the field and checked particular farms to see how delineations applied.

Terry - I checked some of them and it seemed to me that the classification was a little severe for the individual farms we visited.

Bryan - This was due to generalizing. On the whole the classification was OK.

Frank - How about the accuracy of the areas tabulated? Referring to effective portion of the picture did you have any occasion to check areas which you determined in that fashion?

Bryan - We used established county areas and areas from base maps, and prorated our unit areas accordingly.

Wilson - In your determination of cover types say on the 30% crown canopy, how did you arrive at this percentage?

Bryan - This was based first on general field reconnaissance and second on actual delineation of photographs. After practice with pictures you could determine the canopy area fairly effectively from the standpoint of run-off relations.

Frank - After field check you were able later to identify more or less good cover conditions? And, were you able to obtain any relation of forest floor conditions to crown canopy?

Bryan - Yes, that is essentially what we based it on. Through close collaboration between the FS, SCS, BAE we were able to develop a correlation of crown canopy with forest conditions.

Mimms - Economic conditions are very important in attempting to translate the area approach to the individual work program. Is the place to do it on the survey or on the work program? I agree to the need for mechanical land classification however.

Bryan - Individual farms were checked. Over a large number of farms little error was noted. There were naturally large errors on individual farms.

Frank - I agree with Mimms on the need for considering economic factors. In developing a program we should consider institutional elements, farm economics, etc., and work out our program accordingly.

Bryan - The SCS brought up the same question. We took a number of pictures and went to the field and checked individual farms and classifications. Where there were errors, they were rectified in the over-all program.

Ingersoll - The land classification was not quite as rigid as it sounds. Land capabilities were applied in different ratios depending on economic conditions applying to individual soil areas. This gave us a basis for estimating the probable percentage of compliance by farmers in the future program.

Wright - I would like to clarify the nomenclature of the two types of stereoscopes referred to. These are normally known as the reflecting type and the direct vision type. Also the term "mosaic" as used here really refers to photo index maps.

Rogers - You mentioned making a general field reconnaissance followed by detailed area classification on the contacts. I can see where you might get deeply involved. How were soil groups refined?

Bryan - In reality we classified only readily identified features such as slope and erosion.

End of Discussion

Lehrbas - On the Tallahatchie we used similar methods to those used on the Coosa. First we used index maps for covering the entire watershed. An 18" mosaic would be helpful in laying out preliminary reconnaissance work and getting stream channel characteristics. The indexes were probably the most important and valuable factor. Later we had to classify land uses and cover to correlate with information on hydrology. Hydrology in our particular territory was rather lacking.

The area was subdivided into some 10 cover types, 3 being forest types - namely adequate, inadequate, and inadequate and badly gullied. Cultivated land was broken down into bottomland, upland not seriously eroded or gullied, and upland over 10% gullied.

We earlier attempted to classify sheet erosion but got into difficulty and had to depend on ground surveys. Slope classification was moderately rolling, gently rolling, and steeper than 10%.

Our methods were a little different from the Coosa. We covered the entire watershed of 967,000 acres by contacts. The same man also field checked. We also used photos on the sedimentation study but chiefly as "maps" on specific streams. They gave us accurate cross sections.

At first we had some trouble using stereoscopes, especially on slope classification but overcame this through field checks.

I have a little drawing of one of the stands used for reflecting stereoscopes. It eased the work and gave much better lighting. One of these stands can be put up in an hour.

We used the same type of pencil and fine lead that the Coosa used. After field check we inked in the boundaries with yellow pigment ink.

Discussion

Wright - The Eastman Kodak Company has now put out a new transparent sheet that is fastened to the photo with a hot iron. This makes an excellent surface to work on with pencil, wipes off with a cloth and is very inexpensive.

Frank - Is there a vertical reflecting device available?

Wright - Yes, a $1600 machine. You will see it at the SCS laboratory.

Lehrbas - We made a map with Japanese water colors to help the BAE locate land use areas as traced directly from the contacts. Slight discrepancies were corrected by base maps. The scale of the prints varied from 2.8" to 3.2" equals 1 mile. We prefer a 4" scale or at least a uniform scale of adequate size.

Wilson - We do cover typing in California on contact prints.

Massie - You depend on a base for area accuracy?

Wilson - Yes for control.

Frank - How about flood plain damage work?

Lehrbas - We didn't do that type of work except on small tributaries. We had some difficulty differentiating between the first and second bottomlands stereoscopically. We had to make stream characteristic studies in the field using photos as base maps. This was tied in with BAE appraisals. We worked down the stream locating information on the pictures and taking all possible measurements.

Wednesday Afternoon Session

Roehl - I have worked so far only on small watersheds (Codorus and Buffalo). Here it was easier and quicker to make detailed field reconnaissance. We had index maps on the Buffalo and contact prints on the Codorus. Stereoscopes were used to delineate steep slopes and flood plains. Checked immediately in the field.

Discussion

Frank - If you had to do it over again would you want pictures?

Roehl - We would want some pictures. It took 20 days to make a reconnaissance of the whole watershed. On the Susquehanna photo index maps 2" per mile will be used. The trouble in using stereos is in determining cover in grass land country. We have to distinguish between hay lands, idle land and pasture land. No contact prints are available and we're not sure when we will ask for them.

Bryan - We can cover 25 to 30 square miles a day with stereos.

Roehl - We can cover that much now. Another difficulty is that pictures are flown at all times of the year. We get three different conditions when photos are taken in different seasons.

Lehrbas - Pictures flown in certain times of the year are almost useless. Many land use changes occur. Most errors picked up were due to land use changes.

Roehl - We have very little gully erosion on the Susquehanna. Soil is rocky. Diebold plans to use contact prints to determine forest conditions. The area is chiefly in hardwoods.

Lehrbas - I don't think 100% coverage necessary. We worked approximately 160,000 acres. We found about a 25% sample the necessary minimum to obtain the 21 different breakdowns - slope, cover, etc.

Roehl - If photographs could catch deposition they would be helpful. They often don't if taken say 6 months after it occurs because of vegetative growth.

Lehrbas - The same thing happened in the South. The photos are useful to the sedimentation crew in locating "plug" areas.

Ingersoll - Bringing up the question of sampling again - we don't know why but we experimented on the Coosa and didn't have good results. We made a complete coverage and check. We weren't satisfied with a 15% strip sampling. On the Pee Dee we'll break the area down into four major divisions, - forest, cultivated, idle and pasture lands. We might use five for miscellaneous land. Then we'll sample each area separately 25%. We made a check on a complete tributary. Instead of using selected strips from three tributaries we relied on the county agent for a good cross section. This produced much better results.

Lehrbas - When we sampled a 25% section within one physiographic unit we got good results.

Rogers - The AAA method of using contacts may be helpful. Their technicians went through the photographs and determined their respective scale ratios. One of our major problems is scale variation. There is a good chance for cooperative effort here. Some of their material is already worked out. They have photographs to indicate type of work they are doing. They decide on the base elevation and figure certain scale changes which occur. I suggest center ratio - believe it would be very helpful. (Illustrated with contact prints showing correction for "tip", "tilt" and "elevation", and a bisecting "blue" line giving the corrected scale for the entire photo.) This should be done before the photos are sent out.

Wright - Ratio factors are merely a means to the end of enlarging contact prints to a predetermined scale. To differentiate between tilt and tip; tilt is a side movement, tip a backward and forward movement. There's no apparent need of flood control getting too concerned over highly technical matters. Your interest seems broader than that. Most important is the matter of tilt analysis and scale difference due to relief.

Regarding elevation - it is only possible to determine the scale photo for any one plane - other methods are needed to eliminate errors but these are too involved for our discussion.

Lehrbas - What are ratioed prints?

Wright - "Ratioed Prints" are photographs that have been ratioed to some predetermined scale. Ground measurements give the actual scale - the basis for enlargement. A rectified print is a print corrected for tilt and tip. The AAA rectifies a great many of their photographs.

Frank - Use of the central portion of the print eliminates a proportion of error?

Wright - Yes especially if a ratioed print.

Rogers - To determine areas should not ratioed prints be made available early?

Wright - If the information is available it can be used. Confusion exists as to how or whether or not to use different scales over different areas. Everything in certain zone a certain scale. It would be better to get rectified prints but these are difficult to obtain. Rectified prints cost about three times the cost of ratioed prints. The transfer of AAA information to these prints would be a considerable job.

Rogers - I believe for detailed work they might be very helpful and I think we should get the best available.

Wright - If you ask for ratio prints of uniform scale all over it would be cheaper.

McEwen - Photographs for the Northeast are lacking so far.

Wright - In areas of considerable relief nothing can be done to eliminate scale differences altogether.

(End of Discussion)

Williams - We have been on the Potomac such a short while we are really not into the survey. We want aerial index sheets for the entire drainage but are not just sure to what extent we will use prints. The area is 15,000 square miles. We know now we can't

make 100% stereoscopic analysis of the entire drainage. We're trying to develop an idea of Loughead's of delineating the entire watershed into homogeneous areas first. We may try one county first to see how it works out. We have a cover map and the soils men are delineating broad soil areas. BAE is using indexes 1" per mile to work over broad areas; in the hope of working out some system of sampling which will apply to broad slope, soil and topographic classes. How to select sampling is a big issue. We plan to make certain checks. We are very much interested in sampling and are wide open for ideas.

Frank - Flood plain damage work requires one kind of sampling. Other work requires other kinds.

Lehrbas - We are planning to sample the Yazoo.

Back - Not all the Potomac tributaries contribute to damage, nevertheless, we have a big problem and it would take the full time of one man for several years to make a complete detailed stereoscopic analysis of the critical areas. Therefore, we must find the right sampling method soon. We are proceeding by mapping homogeneous areas on the basis of available information such as, topographic maps for slope conditions, soils maps and aerial index sheets for cover conditions. While we have made some progress with the use of index sheets in delineating cover conditions, there are certain difficulties in their use. For overlay purposes, the inaccuracies in the index maps result in some conditions that on the face appear unreasonable. A certain amount of this error can be eliminated by arbitrary shifting of the overlay maps. Some of the men on the survey want to know how to get a greater degree of accuracy on overlay maps; others are not too concerned about this. There is no use in our going too far in the direction of accuracy in one particular item on the survey which is way beyond the accuracy we can expect to find in other phases.

So far as aerial photographs in the Potomac Survey are concerned, we expect to use them for two purposes: (1) studying samples in each problem or physiographic unit area, and (2) studying flood plain damages.

Williams - We don't expect to get any quantitative data from these studies.

Back - Some think it possible to get exact areas by planimetering aerial photographs. It is obvious that this can't be done. In developing quantitative data and in the use of samples for this purpose, we need to distinguish between compensating and non-compensating errors. An example of the non-compensating type of error which has bothered us on some surveys is this - in developing out remedial program we recommend that lands in certain slopes should be shifted to less intensive uses, crop land to pasture and woods and pasture land to woods. However, we do not recommend, as a general practice, that forests on lands suitable for cultivation be cut and the land put into cultivation. Therefore, to the extent

that errors in mapping may result in misplacing forest and cultivated lands on incorrect slopes, our quantitative recommendations will be too severe. How can we get around this kind of error?

Discussion

Lehrbas - Have you sectionalized index sheets?

Back - Not yet.

Lehrbas - I'd like to raise the question of pantographs. We need a standard pantograph for transferring information from photographs to maps. Scale about 6" per mile. We have need for them.

Roehl - We tried to use one pantograph on maps copied from aerial index maps obtained from a State Highway Department. We found that the scale on the maps varied in both directions, making it almost impossible to use the pantograph.

Lehrbas - We paid $3 for ours.

Wright - At Howard University they are making maps for REA using a vertical projector. You may revise your views on the use of a pantograph after seeing one in operation.

Lehrbas - Lots of information from drainage maps and U. S. Engineers maps but would like to get them all to the same scale.

Rothery - We first started using the vertical projector about 8 or 10 years ago in Canada. We studied the photographs, black pencilled all type boundaries (about 15 types). Until we were very well trained we field-checked the photos. The pictures were typed and put in the vertical projector. Type lines were drawn on the maps. The process was very cheap. I noticed that the more men work with stereoscopes the more intrigued they become.

Frank - The ideal would be to use photos in connection with topographic or planimetric base maps made from these photos.

Rothery - When we took Government photographs and typed from them everything fitted perfectly. Using older maps it didn't work well. We obtained pictures at a scale slightly smaller than 4" to the mile. The best photographs were taken in winter.

Wright - 99% of all the aerial photographs the U.S.D.A. owns were taken at approximately 14,000 feet. Enlarging pictures does not bring out more features but merely enlarges those already visible. Our photos can be enlarged 4 times.

Massie - The information in the F.S. Aerial Survey Handbook is of common knowledge, and is for administrative use of Forest Service. Information in it would not be applicable to flood surveys.

Back - If $75 or $100 vertical projectors will do the trick what are the chances of getting some of these out in the field?

Frank - It might be better to have national or regional facilities. Otherwise the cost of a survey would run up pretty high. Skilled men are required.

Rothery - Frank's suggestion is good. The men should do a month's work, send it in and have it returned to the field. There is no need for this if good base maps are available.

Lehrbas - Very few generalized maps are worth using. We need good base maps to cover 8,000,000 acres.

Ingersoll - This will be a big problem on the Pee Dee. I favor the picture point and pantograph method. This is accurate enough especially if boundary areas are available from generalized maps.

Wright - This is OK for flood control purposes. What map scale is considered desirable?

Frank - This depends to a large extent on the type of map used. Scale 1" to mile is OK for small watersheds but not for large areas. Another consideration is whether the map is to cover the entire area or a portion.

Woodward - Pretty good base maps can be made by tracing drainage on the index maps, blotting out the rest, and photographing.

Allen - On the Muskingum no contacts were available for the areas needed. We had considerable information to begin with however, e.g., a watershed reconnaissance in 1935 by Chemistry and Soils.

Flood damage areas were sampled by a 10% random selection automatically taking an area of equal section every 3 or 4 miles up the valley. The same method was used in studying sedimentation, Here enlargements of contacts were employed. In land use planning we sampled 2% of the total area using 8" enlargements and checking results statistically.

We had no standing order for contacts.

Frank - The Muskingum survey is going on for another 6 months. When you return to Ohio you might take up the possibility of using contact prints for specific areas and for certain types of work.

(End of Discussion)

Frank - Stereoscopes might be considered next.

Wright - Very few people cannot see stereoscopically. It is not true that stereoscopes are injurious to the eyes. The

Geological Survey had trouble a few years ago with their people using stereoscopes. It took the matter up with leading oculists and were advised they were good for the eyes.

A direct vision stereoscope gives detail but with smaller coverage. A mirror type covers the entire overlap. The Zeiss magnifying stereoscope is merely a more precise instrument.

Bryan - We learned experience with stereoscopes is needed to realize their possibilities.

Ingersoll - Consideration needs to be given the men who are to use them. There seems to be much variation in ability.

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Frank appointed the following committee to examine the stereoscopes on display and to report on their findings - Bryan, Ingersoll, Wilson, Zabriskie, and Terry.

Thursday - December 7
(Morning Session)

Zabriskie - We haven't used stereoscopes on either of the surveys. Although contact prints were available our people see no advantage in their use as such. (Trinity is 17,000 square miles). The contact prints actually amounted to a waste of funds. The method we are going to follow in the future is to use mosaics or index sheets on reconnaissance and base our sampling on the results of such reconnaissance. As I understand the Tallahatchie survey analyzed stereoscopically 5% of the area or about 48,000 acres.

Lehrbas - We took the complete physical survey made by SCS and used this as the basis for sampling with photos.

Zabriskie - You made the statement that on the Tallahatchie the stereoscopic method was used to delineate cover. What did the field check consist of?

Lehrbas - It consisted of checking questionable items first but found that many of the apparently accurate items were wrong as the photos were 3 years old, and many land use changes had occurred since. Didn't take much checking of many items to classify them. We made mistakes due to the age of the pictures. We had trouble also in determining open land because they look like cultivated lands. Since the area is heavily populated and cut up by roads we could check from a car traveling at a rate of 25 to 35 miles per hour.

Zabriskie - You planned your recommended treatment on the Tallahatchie from samples and these were extended by stereoscopic work to larger areas - why?

Lehrbas - To determine the cost of the remedial program.

Zabriskie - Memorandum No. 44 said we were not supposed to lay out an operations program. Where should we go on a survey? How far should we go and where should we stop?

Frank - This can't be settled here. We should at least line up our objectives as required by the local situation and think them through in terms of how can we reduce flood damage. On the basis of such judgment you should be able to develop a work plan aimed at meeting these objectives. First job is to find out whether there is enough damage to warrant a flood control program: no damage - no flood control survey. If there are damages what kind are they? Are they subject to Agriculture's remedial measures? To what extent are these damages being taken care of by other programs such as that of the Army Engineers? We can justify only as much as we can take care of. Where Army structures will not take care of maximum floods what measures or structures can we utilize to make up the difference and to take care of the land above? Such reasoning provides a legitimate basis for our recommendations. One watershed may need control but the problem may be due entirely to geologic conditions which we cannot modify. In such a case Agriculture has no legitimate basis for a flood program. Again we might find areas where we can do gully erosion control and otherwise increase infiltration capacity or we may have a situation where floods occur in winter and spring due to snow melt. We must go through some such a process of reasoning before doing intensive field work.

As to the use of photographs we have lots of things to consider before we know how much stereoscopic work we want to do. When we determine that it is physically possible to undertake a program and we really can make a contribution then is the time to consider the use of contact prints. As far as mosaics or photo indexes are concerned they should be used early in the game. Read the outline reviews for the Potomac and Pajaro Surveys that we distributed to the field. Get other reviews also and I think you will have a clear picture.

We are gradually eliminating those steps that don't directly answer the question - can we reduce floods.

Zabriskie - When we looked at the stereoscopic work it looked like a lot of detail not warranted by results in our type of country. It would have been easier to make a reconnaissance survey more in detail on mosaics and then base the sample on results so it could be expanded. We plan to make our reconnaissance only as detailed as we will need. Thus we recommend terracing all slopes over 6% in certain areas and all over 4% in other regions. Hence there is no need to get smaller slope differences than 5%. Stereoscopes can be used as the Army does in locating structures and studying flood plain conditions.

Sampling is the big problem. We must disregard special techniques and think in terms of the objective. We figure sampling will be OK. If a sample is taken even if very small, say 1%, it will be good for uniform conditions. In reconnaissance we are only going to delineate large soil groups. On range land on the Concho it is hard to delineate areas with stereoscopes. We believe reconnaissance with mosaics will fill the bill and give us basis on which to sample.

Frank - Remember we have got to evaluate our programs in terms of costs and benefits.

Zabriskie - Stereoscopes can't indicate sheet erosion.

Frank - Some types of soil show distinct color change when eroded and this is revealed by lighter shades on the photos.

Zabriskie - You can remove 2 feet of top soil and you can't tell difference. Remove 3 feet and you can tell.

Back - You plan to use no photos, not even to supplement reconnaissance? You do not have maps showing topography and soils? You say you have to go into the field to get these? (Refers to Concho Survey)

Zabriskie - We have a few quadrangles, some indexes and mosaics.

Ingersoll - The variables of concern are soil, cover and erosion. You don't believe you can get these stereoscopically?

Zabriskie - For purposes of formulating a program we don't need stereoscopes.

Ingersoll - When you make a reconnaissance with index sheets do you visit every place?

Zabriskie - No. We can make a reconnaissance detailed enough on which to formulate a program at the rate of 20 - 25 square miles a day. Depends of course on roads.

Ingersoll - The value of surveys is in the final analysis. The degree of dependability of the cost-benefit ratio must be considered. We can do 4,000 square miles in a year with stereoscopes. Don't you believe we'll get results even on large watersheds?

Bryan - I agree though we need to change our methods in use in order to use photos more effectively.

Zabriskie - By reconnaissance I mean covering the entire area.

Ingersoll - This is OK for soils but the photos will give us cover and slope.

Zabriskie - Will stereoscopes on range lands give us cover differences? Tell us the different kinds of grasses? I don't believe stereoscopes would be of much help here.

Back - Type of country needs to be considered.

Lehrbas - We find stereoscopes very advantageous in our country but in range country I believe we would disregard them.

Frank - Has anybody on your survey really made a study to determine the possibility of identifying range cover by stereoscopes?

Zabriskie - No.

Frank - I believe it would be well to look into this. Why not give it a fair trial? Could you enlarge a little on your statement that contact prints with stereoscopes are useful in locating dam sites and flood plain damage?

Zabriskie - Our experience on flood plain damage is not very extensive. We ran into a snag in trying to find out how much area was covered by floods, mostly agricultural. With the stereoscope we could probably pick out the limits of certain types of floods. These can be related to hydrologic data on flood flows giving the economists something to base their damages on. Two factors are involved here - (1) Lack of accurate information on past floods and (2) discharge of stream in relation to height of flood. Here contact prints would be valuable.

Re: the location of dams: This is important in range areas. We've recommended a large number of dams on some surveys. If we are going to recommend a structure we should investigate the site. The Army would never recommend a dam unless they had thoroughly investigated the area. If we can find certain sites where we will have fairly low cost we can use stereoscopes to good advantage and save considerable field work.

Lehrbas - Re the flooded areas. In our experience we could not determine the different heights of floods by stereoscopes. In Mississippi the flood waters go through the swamps before they top the levees and then they cover everything. Contact prints here can be used directly as base maps on which to check location of dam sites. We had 14 different overflows this year. The factors here are period of inundation and duration of flood. Not necessarily amount of land overlaid. Inundation does not necessarily mean damage.

Zabriskie - This varies with different regions. Some portions of the Trinity could have been studied stereoscopically if dam sites were found feasible.

Frank - In using index sheets are you also saying you have no need whatever for stereoscopic analysis, or is the need for stereoscopic analysis limited to areas in need of intensive study? I have in mind that pictures are often valuable in saving the field time. Pictures cost money and if we are going to do much field work we should not use contacts also.

Zabriskie - We could make a reconnaissance on an area and get results which are better than using the stereoscope.

Bryan - Can you do 500 acres an hour in the field?

Frank quoted from a letter from the California Forest Experiment Station on the use of photos in locating and checking dam sites:

"..... (b) the development, from enlarged aerials, of contour maps of sites to be used as debris storage or retention dams.

.....

"With reference to item (b) above, the method of developing these contour maps is as follows:

"(a) Prospective dam sites are located in the field and these locations are spotted on the aerials.

"(b) The portion of the aerials in which the reservoir occurs is enlarged to two or three diameters.

"(c) The enlarged aerials are taken into the field and by means of a chain and abney level, profiles up the canyons, as well as several cross-sections of the canyon, are laid out, with reference to points on the aerials that can be identified.

"(d) With the elevation and distance of these points identified on the aerials, they are put under the stereoscopes and contours of sufficiently small intervals to make volumetric surveys are drawn in."

Back - Re. the question of field reconnaissance versus use of contact prints. The final decision depends on the extent of other map information available, e.g. on soils, slope, etc. We have ample information on the Potomac. We can block out general homogeneous problem areas by use of index sheets and other maps and on that basis delineate samples in each type area. We have 't decided definitely but we believe our sampling will be a combination of contact prints and field work.

Zabriskie - Your watershed is 11,000 square miles. Tackle the problem same as we did.

Frank - You could use contact prints without the stereoscope and get more information than from the index map.

Zabriskie - That is how we used them.

Ingersoll - Contact prints would be especially valuable if taken just after major floods occur.

Zabriskie - Can we get repeat photographs?

Frank - Repeat photographs when flown will be valuable in the operations program by showing a progression of events.

Wright - There is a big photographic program under way. The AAA might fly certain areas about three years apart. Some areas never change, others change considerably over a short period of time.

Frank - I don't think we should request repeat photographs except in exceptional cases.

Wright - You probably receive a map every month issued by O.L.U.C. showing the status of aerial photographs. This map does not show rephotography because we always furnish the latest photographs.

Frank - Could we get information as to whether areas had been flown before?

Wright - Yes.

Frank - Could we get the earlier photographs if we wanted them?

Wright - Yes. Every photograph shows the date when taken.

Back - Since time of season is important, in certain areas where there are two sets of pictures could we mention our choice?

Wright - The Departmental records only cover what Department has done. We might find that the Geological Survey has flown an area years ago. These old pictures might not be any good except for historical records and then they would prove useful.

Frank - We might follow this up and inform the field.

(End of Discussion)

Wilson - Methods of Classifying Cover in Southern California
(Illustrated with Charts)

We have undertaken an experiment over a period of years to determine the possibilities of identifying cover stereoscopically. Scale of prints varied from 3" - 4" equals 1 mile. We used the direct vision stereoscope for maximum vision; the mirror type for the general view. Four diameter magnification is sufficient to give details of the principal cover type. Only the effective portions of the photos were used.

Six elements are easily recognized after field check: conifers, hardwoods, shrub, grass or herbs, rock and bare soil. It is difficult, however, to distinguish between bare soil and grass where the cover is very thin.

Age class distribution: 5 classes recognized stereoscopically provided 4" scale photos are used. We depend on such characteristics as apparent height, shape of crown, shape of crown shadow (especially in the open). For this we prefer photos flown in early fall or spring.

The broad cover types were then plotted on sheets; percentage of various cover species in given class had to be field checked. This was done by using portable high and low power stereos in the field with contact prints showing type lines. Age class distribution (conifers only) was plotted on overlays.

Stand densities for tree and shrub areas were determined by mechanical grouping of various stands.

Note: For further details see - "A Vegetation Inventory from Aerial Photographs," by G. F. Burks and R. C. Wilson, Photogrammetric Engineering, Jan.-Feb.-March 1939.

See Appendix B. "Preliminary Instructions for Vegetation Type Map and Cultivated Land Classification by Office and Field Interpretation of Aerial Photographs," (March 3, 1939, by R. C. Wilson (Forest Service).

Discussion

Garver - Was density based on distribution of crown canopy?

Wilson - Yes, from photos; these permit grouping in homogeneous areas. By ground sampling we were able to obtain a basis for extending areas stereoscopically.

Lehrbas - Might the poorly stocked stands have a good brush cover?

Wilson - Yes.

Lehrbas - Height of flying?

Wright - About 12,000' above ground. We considered the use of different types of film. Panchromatic is not as good as orthochromatic or infra red for certain purposes.

Wilson - We're hoping for such an experiment over sample areas with different film and color filters. Rykers work on timber species determination was based on very large scale photos, some 800' per mile. Some types of film would make soil determination easier by greater contrast in color tones.

Wright - Panchromatic film was specified previously because of its speed but now the speed of other film is increased and the specification was removed. Color differentials are needed especially in dust bowl areas.

Wilson - We've tried the use of orange filters.

Garver - Would such films and filters permit distinguishing between Douglas fir and ponderosa pine?

Wright - In some cases, especially if the film is properly exposed.

Frank - Were differences in ground cover and forest floor conditions between different cover groups noted in making field checks?

Wilson - In dense stands with heavy canopy we couldn't tell anything about litter. In open stands we could tell whether grass or shrubs were in the understory, or whether a light cover of litter. We didn't try to approach it from that angle, though field check indicated a definite correlation.

Frank - Was fire damage taken into account?

Wilson - Passed photograph around. We had some burned type. Shrubs come in heavily on burn and also indicated by lighter shading. This photograph taken about a year after fire.

Peterson - Re. area determination?

Wilson - After getting boundaries on the photographs we projected them on planimetric base maps where available, via vertical projectors. The control points were used for orientation.

Wright - This entire method was written up by Mr. Wilson and one of his associates and published, in Photogrammetric Engineering. It may be possible to get reprints.

Wilson - We have more recent writeups. Thinking you might be interested in costs I might say that even in this experimental work we have managed to cover particular quadrangles with the same cost as by field work alone. Naturally we got a more accurate picture of the country. We expect to cut costs further.

How soon may we expect to get a finer grain film?

Wright - Such film is now available. If you specify it you can get it. I saw pictures taken in Florida at 1 - 40,000, (1 inch = 3333 feet) and enlarged to 660 feet per inch. They looked better, clearer and sharper than the usual enlargement.

I've been looking at the symbols Mr. Wilson used. If we can use the same symbols throughout the Department it would mean

that much faster standardization of symbols in the Department. There is a conflict now in some symbole in the Federal Government, the Department and even for that matter within the Forest Service. Various divisions use various symbols for the same things. We should have one set of symbols for the entire Department.

Peterson - The National Resources Planning Board has issued a report on standard map symbols. I understand this is being revised.

Frank - Do you think it advisable for the stereoscope review committee to give their ideas?

Wilson - I think it advisable to get several different stereoscopes for different types.

Frank - Tomorrow we will discuss use of aeroplanes in making reconnaissances particularly autogiros. The Flood Control Committee has authorized me to conduct an experiment with Northeastern group in reconnaissance mapping from autogiros.

Wright - I'd suggest taking oblique photos instead of sketching.

Frank - With ordinary cameras? If so we could get samples of major conditions.

Wright - Yes.

Rothery - Canadian foresters have used these to great advantage.

Meeting adjourned at 12 Noon. The afternoon was spent in inspecting the AAA and SCS photographic laboratories.

Friday Morning - December 8

(Summary Discussion)

Frank - I'd like to ask Bryan what he thinks now in the light of the discussions on the need of getting greater accuracy from contacts at the expense of much work. I'd also like to get your recommendations on the application of improved techniques and on the scope of application to future flood control surveys.

Bryan - On large watersheds we have to depend on sampling after problem areas are located. On a small watershed, like the Cocsa, we might make an overall coverage in a fairly short time. However on a watershed of say 13,000 square miles we must depend on a more rapid method of survey. I've come to the conclusion that on the Pee Dee we have first to locate tentatively our flood

and silt source areas and any special areas we want to study and then make detailed stereoscopic examinations. We depend more on index sheets in our preliminary examinations of these areas and on prints later on. The sedimentationists also want contacts in studying valley fill. Flood damage studies for entire river system also can use contacts stereoscopically to advantage.

Frank - In the location of flood problem areas is it desirable to use index sheets?

Bryan - Lots of material is already available from other agencies. We would use all this information along with the indexes.

Frank - What about mosaics vs index maps? Is the difference enough to warrant consideration?

Bryan - Don't believe there is. Don't see need for mosaics.

Frank - Where we have 9 lens photographs available would they be obtainable on surveys?

Wright - Nine lens photos give a composite picture which has been rectified to true scale. They're very expensive. While they are rectified to true scale of the center picture, there is still the obliquity on the others which can't be taken out. Nor can they be viewed very well stereoscopically. Obliquity means the pictures were taken at an angle sideways. (Illustrates with diagram). They're not satisfactory in areas of relief.

Back - When we saw the pictures in the AAA laboratory we thought of 9 lens pictures in place of index sheets for making base cover maps.

Wright - Too much field work would be required. Much detail is invisible in areas of relief. For map making they're very good: what one photo misses the other gets.

Back - In making the cover map we're primarily concerned in getting blocks of cleared land.

Wilson - Aside from invisible areas how about shadows? We're interested in cutting out forest land from other lands. Dark shadows are not necessarily forest. They might be anything else.

Bryan - Little has been said about hydrologic analysis and the use of contact prints and stereoscopes on gaged tributaries. Mr. Ingersoll is of the opinion that contacts permit the best study we can make to obtain proper run-off coefficients.

Frank - Some people here favor the use of mosaics over index maps to map information on.

Lehrbas - Here the cost element comes in.

Zabriskie - What is the difference in cost between index and mosaics? Does the AAA make mosaics?

Wright - No. No one in the Department. Relative cost is very difficult to determine. Index sheets cost us little. To make mosaics you must match each individual photograph and get its proper scale. Costs probably $1 a square mile or more.

Frank - Contact prints might be enlarged in special cases.

McEwen - The Land Economics Division could use mosaics if available. Cost might be justified if other agencies are also interested. Any chance of getting cooperation established in Department?

Wright - There is little interest in mosaics. If a need is shown, mosaics could be made. Almost two million square miles have been flown in the last five years and no requests have come in for mosaics, except that the SCS however did some mosaic work under contract on the Navajo Reservation. All the agencies and bureaus are using photo index maps, however.

Note: The SCS has prepared controlled mosaics scale 1" = 1 mile for a large area in the western states comprising portions of Washington, New Mexico, Utah, Colorado, Arizona, Wyoming and Idaho. State maps are now being prepared showing the status of aerial surveys by the SCS and the portions for which mosaics have been made. These maps also show counties. It is hoped that copies will be made available to the field.

Wright - I will read you the definitions for mosaics. There are three kinds - Uncontrolled mosaics, controlled mosaics and precise mosaics.

"Uncontrolled mosaics

What is usually referred to as a mosaic map is one built up by joining together prints of individual near-vertical-axis aerial photographs or parts thereof in such manner as to have the topographical features appear continuous and to present a comprehensive view of the entire area. These maps are an assemblage of separate individual photographs matched by images alone and contain all the errors inherent in any photographs which have not been rectified to a true horizontal plane or scale."

"Controlled mosaics

This type of map, in appearance, differs little from the uncontrolled mosaic heretofore described, but is usually more accurately "laid" as the photographs have been enlarged or reduced to fit predetermined positions independently plotted on the base sheet. These points are usually topographic features which are identifiable on the photographs and have been located on the ground by regular surveying methods. This type of map is fairly reliable, but contains all the inaccuracies of any aerial photograph. To a certain extent, however, these inaccuracies have been partly overcome by resitution of the photograph to known positions before being used in an assemblage."

"Precise mosaics

This term is often used, but I have yet to see a map which would literally conform to the descriptive title of being "precise". It is possible, within the bounds of reason, to take photographs so closely together over an area that the central portion of each photograph will overlap the central portion of all the adjoining photographs, and, if only these central portions, after being rectified to one horizontal scale, are used in an assemblage, a mosaic map closely approaching a true orthographic projection could be secured. The cost, however, would probably be prohibitive. The term "precise mosaic map" for most practical purposes may be regarded as a misnomer."

Frank - We're all in evident agreement that the stiff cost of getting mosaics would not make it worthwhile.

Rogers - Why not investigate further?

Frank - Right now we're getting photo index maps for nothing. Whereas in the case of mosaics you have the manual job of actually preparing each sheet.

Rogers - Once we got the ball rolling for mosaics the cost would come down.

Lehrbas - We're satisfied with indexes.

Back - Speaking for the Potomac, I think most men on the survey would be better satisfied with mosaics for one use and that is to make a general cover map. They can be used in blocking out areas for study.

Bryan - I'm inclined to think that particular areas for study could be gotten from contact prints and the indexes would be sufficient for cover.

Lehrbas - The Flood Control Committee might look into two possibilities of mosaics, at least the first two kinds of mosaics. To be worthwhile they must be made from ratioed prints.

Frank - In addition to use of photographs for analysis of run-off coefficients is there any other use? e.g. infiltration studies?

Bryan - On our past survey infiltration work we got off to a late start and then we didn't get over it all. Contacts will be of help to that section of the survey.

Frank - Infiltration studies may be undertaken not only on selected small gaged watersheds but on other areas as well. What would you want contact prints there for?

Bryan - To get about the same indications as we would require in hydrologic analysis for the particular breakdown of cover, relation of various soil groups, etc.

Hertzler - First of all there isn't much need for going into great detail in getting land use either for hydrologic or infiltration data. We've got to use some caution. There's no use getting data just to be getting it. I believe index maps would be quite OK to delineate homogeneous areas for hydrologic studies. We do need contact prints for sample run-off studies but even here there's no need for minor slope breakdowns.

Frank - Can we generalize by agreeing on some grouping of slope classes? Doesn't it depend on whether there is great relief or not?

Hertzler - On the North Concho the significant slopes ranges are from 0 to 5% and 5 to 10%. On the Coosa the slopes range from 0 to 100%.

Ingersoll - To obtain run-off information for gaged watersheds we need some knowledge of the coefficients of different land uses in order to appraise a plan of improvement. Extra refinement is needed to extrapolate the data.

Hertzler - That is the thing to do when objectives are clearly determined. My objection, however, was to refined data collection for the watershed.

Frank - We mentioned two uses for contacts: in studying gaged tributaries and in developing a plan of improvement. To what extent and over what portions of the area should we use contact prints in the latter case?

Ingersoll - Sampling is not the same here due to different purposes and types of area.

Frank - How can we use index maps on infiltration studies?

Lehrbas - As a basis for distribution of samples.

Hertzler - Infiltration is essentially the same approach to finding homogeneous areas. Index maps help to find out what you have but other types of information and techniques plus judgment are needed also. For example the Coosa area has 200 soil types. Soils groupings are essential based on several factors. A certain amount of field work is also required. Slope may have a serious effect in very flat country. In other areas differences in soil porosity may be a governing factor.

Wilson - In southern California we need contact prints to pick "sore" spots on road banks. The indexes don't serve here. It makes for splendid sampling because we are later able to define homogeneous groups stereoscopically.

Hertzler - I agree contacts are needed under certain conditions.

Wilson - In planning for revegetation how can index sheets help in selecting planting sites?

Hertzler - This depends on regional characteristics.

Bryan - We developed a form for car reconnaissance to record road bank erosion. We also developed a scale, watched car speed. Just as we came to a cut or fill put down a dot. When we got back in the office we refined this information stereoscopically.

Lehrbas - We used a 24 bank crop meter to excellent advantage.

Rogers - They might be valuable on preliminary examination reconnaissance.

Frank - Coming back to the plan of improvement to what extent should we depend on contact prints?

Bryan - In locating dam sites and other improvements of that nature. Indexes are of no value here. Even contacts are not sufficient alone. We might figure the drainage area, etc., but when we arrived at the point of specifying just where the dam should be we ran into engineering problems.

Ingersoll - Since the plan of improvement is based on sampling of small areas stereoscopic analysis is important in providing accurate information on many conditions. Using only indexes we'd miss many conditions and be unable to develop unit costs and assigning charges to flood control.

Frank - You might find it desirable to get contact prints for portions of the area. Once you've determined where and how you want to sample you might request strips of contact prints accordingly.

Lehrbas - Contacts are needed both for damage studies and problem area analyses.

Frank - We might confine contacts in the plan of improvement to sample areas. Wouldn't it be fair to justify the request by explaining the specific purpose and area to be studied? Contact prints would be needed in most cases for gaged tributaries much before their use in improvement planning. The economic studies would require other uses of prints.

Lehrbas - In our territory land uses vary almost directly with physiography.

Back - Our plan (Potomac) is to work with the physical scientists when they select the samples and we'll try to have enough economic information to be of value to both. If the sample does not give enough information we will supplement it. The question of contacts ties in with the adequacy of sampling both quantitative and qualitative.

Frank - Clarification of purpose of the survey and the extent of accuracy required should help here. Sampling should be determined before contacts are requested. Another question: for a tributary of 100 sq. mi. is it necessary to cover the entire area?

Ingersoll - My reaction is that we should cover the entire drainage if we are going to extrapolate the information.

Frank - In the course of picking out a watershed for special studies you will take into consideration that it is typical of a larger area.?

Ingersoll - Yes.

Frank - What percentage of a total watershed would you consider a fair sample in selecting gaged tributaries?

Lehrbas - We gaged 12 small streams totalling 6,000,000 acres, an average of 20% of the total area.

Ingersoll - We selected tributaries which haven't been gaged yet because of difficulties in installation.

Frank - Is it possible to select areas before using contact prints?

Ingersoll - We don't need contact prints to pick areas.

Frank - Why not wait until you have established gages before asking for pictures?

Bryan - Believe you can do that.

Davis - Are contacts required for the whole flood plain? Can't requests be deferred and only indexes requested at first?

Wooten - Wouldn't it depend on conditions on the watershed?

Lehrbas - I spent 6 days with four men on reconnaissance of about 7,000 acres. We selected about 1/3 of area as not requiring any further study, 1/3 as representing a severe problem and 1/3 as questionable. It follows from this that some pictures can be eliminated.

Davis - I assume we shouldn't order pictures for flood plain studies until some such check has been made.

Summary:

It was agreed best to study available data first, then to make brief field reconnaissance before requesting contacts and then only to request them for sections not previously covered.

Woodward - Order contact prints by index number and you will save considerable work.

Davis - What is the usual scale?

Woodward - The majority of negatives are 1 - 20,000, (3.1" = mile). Only 3 - 4% of the photos available on 4" scale.

Bryan - 3.1" scale is OK for our needs.

Davis - When you furnish prints, what is the difference between present cost of contact and enlargement to the 4" scale?

Woodward - Contact prints are 15 cents per square mile. Enlarged to 4" they cost 20 to 25 cents.

Davis - Should we leave it to field to designate the scale?

Lehrbas - It would relieve a great deal of calculating to have ratio prints.

Davis - It would be helpful to have all at a uniform scale.

Bryan - I believe the field should have to justify it.

Frank - Is it understood now that unless specified, contacts will bear the 3.1" scale?

Davis - Field should know what scale the photos are flown at.

Frank - Is it feasible to "blow" the pictures up?

Woodward - Yes, to 8".

Frank - Any difference in cost?

Woodward - Very little. I suggest that the field specify scale wanted in all cases.

Frank - If the field wants to specify the 4" scale would the additional cost be much?

Woodward - Not more than 10 cents a print.

Wright - We don't want to ask for print of 1-20,000 when the original scale is 1-15,000.

Frank - When you get the index map will you get the scale of the negative also?

Woodward - A stamp on the index map indicates the scale.

Frank - In that case the field can decide for or against enlargements.

Wilson - Would we get as much detail on an enlargement?

Wright - Yes.

Wilson - We found the detail was not reproduced when blown up for our forest type studies.

Wright - There are exceptions to any statements. You may not have gotten it in your case but in general the same detail will be available.

Lehrbas - When we make request on watershed where two different scales are involved can they both be blown up to same scale?

Wright - Specifications permit 5% differentiation; 5% over or 5% under. Varies with the contract.

Note: Where negatives are to different scales, prints can be made at same scale.

Lehrbas - In such cases we will specify 4" uniform scale or better still 3.1" for clarity.

Woodward - Practically all orders are for the negative scale.

Wright - Contact prints are the same as the negative.

Rogers - Is there any indication on the photos to know whether they were ratioed or not?

Woodward - I don't remember seeing requests for enlargements for flood control.

Wright - Don't think that when you write in and ask for ratioed prints that each print is going to be ratioed individually so that each print regardless of its scale will be exactly the same as every other.

Woodward - We would group all photographs having the same approximate ratio.

Wright - Where are you going to get ratio values?

Woodward - We must have AAA or the best available data.

Frank - As long as we get rough measurements anyway why do we need so much accuracy in photos?

Bryan - We want to keep in mind that we're heading towards an action program. Will never arrive at same accuracy in action program.

Frank - I don't think it necessary to use ratioed prints.

Lehrbas - We found quite an error in computing from photos 3.1" and 2.8" respectively.

Frank - What do you consider an error? If you keep in mind that a flood survey yields estimates only and the actual program must be worked out in detail we can permit a reasonable degree of error.

Back - If we can get prints all on one scale shouldn't we request them?

Frank (To Woodward) - Could you give us prints fairly uniform in scale?

Woodward - Yes, with slight variations. How near to scale do you want - 2%, 1%, 5%. A 2000' difference in elevation might result in 6 to 8% error.

Rogers - We only use the center portion of the print.

Frank - Differences are unavoidable even here in areas of strong relief. Should we consider limiting the error to say 2%?

Woodward - I would say 5%.

Wright - In areas of great difference you could get two ratioed prints from same negative.

(All agreed on a total limit of error of 5% in scale of the contact prints, this to be consistent throughout the job. Can't do much about small variations in photos anyway. Field should specify limit of error. Not much difference in cost or delivery time.)

Frank - Re transposing material - The field develops its base maps from the best data available. Should we use base maps rather than "maps" made from photos?

Ingersoll - In using base maps, say 1 - 500,000 it is difficult to transfer information because the drainage details are not shown. Hence we need to make controlled mosaics of drainage lines and to do this we prefer a uniform scale of index sheets.

Wright - Couldn't you do this? On all composite photo index sheets can't you gauge the positions of points that you can identify? From the known distances between these, then scales the distance on your mosaic. Either accept the scale of the mosaic or ask that the photo be reduced to scale desired. This is good enough for field purposes.

Ingersoll - This is OK to give us drainage pattern points accurately. I suggest a draftsman go over the drainage lines first before reducing, showing them in white ink so they'll stand out.

Davis - Have you discussed scale of index sheets themselves. Most of them are going out now at approximately 2" per mile.

(All agreed on the 2" scale for photo index maps).

Lehrbas - How much difference in error in bringing two index maps together?

Woodward - Much difference.

Wright - It was never originally proposed that these photo index maps be anything but references to relations of contact prints but they are now beginning to serve other purposes. For flood control purposes they serve almost as mosaics.

Woodward - As other purposes develop the specifications can be tightened.

Ingersoll - Suppose we ask for 50% of the area in single alternate contact prints?

Frank - What about difference in cost between these and indexes?

Woodward - The first contact print cost 20 cents, the second, 6 or 8 cents.

Lehrbas - On areas where we are making detailed studies we would like to have 8" prints for the SCS Conservation survey crews.

Davis - We have now standardized most conservation surveys to the 4" scale. We found the men inclined to go into too minute details on the larger scale.

Friday Afternoon Session

(Sampling discussion summarized)

Rogers - I believe we should have more seminars. I don't think Washington fully realizes all our problems.

Wooten - Second the motion.

Frank - The field shouldn't hesitate to ask for help.

Wooten - I understand the Coosa survey experimented in sampling by use of every third or fourth flight line.

Ingersoll - We experimented in two ways - by random strips (20% sample) and by tributaries. We asked the county agent to name 3 most representative streams and made a 15% sample on that basis. This was far better than the strip method. The reason is probably fact that they were more representative.

Back - Shouldn't a limit be set on the degree of accuracy?

Frank - Yes.

Ingersoll - In one county we tried to get a tabulation of cover classes. Two or three didn't occur in any sample that we took. Unless you have adequate sampling you miss very important items.

Lehrbas - How can we check the degree of accuracy unless we do it at random?

Rogers - Osborn (statistician - FS, Washington) told me that if he gave much thought to the problem he could make a good analysis of it.

Frank - If we want such help we must state our problem. This is important in reducing the number of photos wanted, and in reducing survey costs.

Back - Statisticians can help. We need statistical measures easily and quickly applicable in the field.

Back - On the Potomac the county maps are best. We will take soils slope and cover maps and try to block them out by counties. The Muskingum survey did quite a bit of sampling work. We could probably get some help from them.

Wooten - They found that you could take a fairly small sample and get good results. As Rogers suggested if we can have a small group work together it would be helpful.

It was agreed that a study be made of the problems of sampling in flood control surveys.

Report of Committee on Stereoscopes

Frank - May I have the report of the committee on stereoscopes?

Terry - The direct vision ground glass type is best for studying small areas and the Fairchild T-5 to give overall coverage. The coverage is cut down when you use special lenses.

Wright - The T-5 is not a magnifying stereoscope. The Ryker has the merits of both. No adjustments of photos are needed.

Frank - The big difference in cost between a mirror stereoscope such as the T-5 and the single ground glass type we've had made for $7 each is a factor.

Wright - For $80 the Ryker provides both overlap and detail. Good illumination is particularly important in using stereoscopes.

Bryan - In using the T-5 for a couple of weeks straight one doesn't get eye strain. I checked several pictures under the Ryker and some under the Fairchild. I prefer the Fairchild for overall studies. It is easiest to get accustomed and with proper lighting is very serviceable. For study of limited area a small instrument of the eye glass type will do. We ought to incorporate a table of some design whereby we won't have to spend lots of time building a special table. Also a couple of tin slides to permit the photos sliding up and down. We should also develop some sort of holder with clip for holding the picture and still permitting it to slide up and down.

With the direct vision type we can't use slides. The manufacturers ought to be interested in developing a special table.

Wright - For a quick way to bring pictures into stereoscopic fusion - take a hairpin, separate the points until they are at the pupillary distance of the eyes.

Lehrbas - By using the match lines on the photographs we have no trouble bringing them into focus.

Frank - Would you get just as good results if you used photos overlapping along the line of flight sideways?

Wright - Not quite. They don't fuse together nearly as well and there also may be a little scale difference.

Ingersoll - My mind is not made up. I like the Ryker the more I look at it. It has better lighting facilities for other attachments. We need the direct vision type also.

Bryan - I would prefer the direct vision type to the mirror for steady work.

Ingersoll - Technicians on the job don't like the small type.

Bryan - If you could get a little more magnification on Ryker I would like that just as well.

Lehrbas - Does the Ryker at present have any magnification?

Wilson - Just enough to eliminate the extra distance as if you were looking at it from the naked eye.

Wilson - Can move the Ryker up and down.

Wright - You are all overlooking difference in price.

Wilson - We have just put out a bid for a special instrument, giving more magnification through a mirror system. Ryker got the bid. It will be mounted on a base board and will have an x and y movement. We have ordered 3 instruments to cost $165 or $185 each. This is strictly an office machine.

The main features of the special magnifying office stereoscope now being constructed for use in the intensive study of vegetation types on aerial photographs contracted for by California Forest and Range Experiment Station are:

1. A wide range reflecting type of instrument for use in the office.

2. Mirrors to be of good first surface quality, pancro or better.

3. Auxiliary lens attachments to allow actual linear magnification of photo-images as high as 12 diameters.

4. Eye piece adjustment to allow good stereoscopic fusion of images on overlapping photographs that have average differences in scale up to 5%.

5. Instrument to give a wide field of view under low magnification and to permit stereoscopic study of larger size photos than regular 7 x 9" contacts.

6. Auxiliary lighting attachments for illumination of photos.

7. Incorporation of mechanism within the instrument to permit movement of field of view in an x and y direction over the prints.

8. Instrument to be mounted on a tilting table to permit convenience in study by operator when sitting down.

Frank - What about portable stereoscopes?

Lehrbas - No need for these.

Frank - What about the folding type for office use? (Fairchild and Smith).

Wilson - Mirror stereoscopes are all much the same. Additional lighting equipment is handy but we use a desk lamp and mirror.

Bryan - We used three on an inclined table.

Lehrbas - Until such time as Wilson gets the answer to our prayers let us hold up on any decisions.

Frank - Wilson, about your comment on mirror stereoscopes - are they the same regardless of people's opinions?

Lehrbas - We had one you had made over at the TVA and it wasn't satisfactory.

Frank - Is the chief difference between the T-3 and T-5 merely in lighting arrangements?

Woodward - I found inexperienced men want T-5 rather than the small type. It might be well to have the T-5 for training purposes. After using the T-5 a month or more they get an idea of what they are trying to find.

Rogers - We might double up the lenses and get greater magnification.

Bryan - If T-5's weren't mentioned we'd get along just as well with a cheaper type.

Frank - The value of these instruments probably doesn't compare with their cost. I believe good stereoscopes can be made by some competent person much cheaper. Lenses can be ground for much less than we pay now.

We've been discussing the mirror and low power direct vision types. What about the high power lens?

Bryan - In our case they would be supplemental.

Ingersoll - I agree they'd be useful.

Lehrbas - In volume would they be cheaper?

Frank - Is it agreeable to wait a while before ordering costly stereoscopes?

Lehrbas - For surveys with no stereoscopes I believe they should wait. These already having the mirror type would like the high powered direct vision type.

Lehrbas - We have need for the high powered type.

Frank - The high powered type could almost measure gully depths.

Wilson - I'll send in a report on the new type Ryker after we have tried them.

Woodward - You might get a high powered lens ground and attached to other stereoscopes.

Frank - We might have some lenses ground to 3-4 diameters and try them out. We all agree the mirror type is not sufficient though we might have a low priced one in the office for training and for composite area studies.

Airplane Reconnaissance Mapping

Frank - We now might discuss the use of airplanes for reconnaissance work in PE's and for survey reconnaissance. The Flood Control Committee has authorized an experiment in sketching from autogiros at the request of the Northeast group. In my own experience the airplane is quite useful for rough classification of conditions over large areas. We used a USGS base map

4 miles to the inch. We gridded the map, marked the roads, larger drainages, and other outstanding features that would help keep us oriented. We used observers in the plane. One with the pilot watching airspeed and compass direction and calling out names of towns, road intersections, etc., to aid the mappers judge the proper scale. Then we had a man on each side with a section of the map. We agreed in advance not to map anything beyond a given distance, say 5 miles. We mapped in points of interest for later follow up on ground, such as the extent and character of erosion, and distribution of cover types and conditions. The plane we used made about 150 to 180 miles an hour, flew about 3-4000 feet above the ground. We got good results but were handicapped by the speed of the plane. Autogiros are now being used increasingly for such purposes. The Bureau of Entomology has been using them for spotting bug infested areas to good effect. They were particularly helpful in mapping wind throws in the New England hurricane area. With autogiros you can cut speed down to about 30 miles an hour and less for short periods due to their hovering ability. They're also safer in rough country. In this connection it might be worthwhile to use photo indexes rather than maps where these are available.

Lehrbas - I've flown over our area. It gave me a better impression of the seriousness of the problem. But with index sheets available I can't foresee any need to improve upon them with airplane flights. In a general reconnaissance where you don't have index sheets planes may be very valuable as for example on PE work.

Davis - Index maps are now available for some watersheds to be covered by PE's.

Rogers - Index sheets are a wonderful help. It is almost unnecessary to go to the field on PE's.

Note: Discussion of this subject was not as thorough as desired because of the general lack of experience by those present in this type of work. Reconnaissance flying of the nature described is done at far lower elevations than those at which aerial photographs are taken. Much detail not visible even from contact prints, let alone indexes is observable not only because the observer is closer to the ground but also because he has the advantage over the black and white photo in being able to distinguish among all shades and gradations of color.

Merely making mental note of features of interest is not enough. The real value of plane reconnaissance is in recording on maps the items of value-interest.

Nor is plane reconnaissance advocated as a substitute for ground reconnaissance but rather as an aid to it, and as a further aid in interpreting index maps. Above all the need for adequate preparation for plane mapping must be stressed. Wright's suggestion that oblique photographs of representative conditions be taken (by any type of camera) is worthy of further study. Assuming index maps are available, areas to be photographed obliquely could be spotted in advance and the pilot advised accordingly, thus ensuring proper distribution of "shots" taken.

Davis - Do you want to consider index sheets for PE's?

Rogers - If you have USGS maps you can work out watershed boundary. They're fine for general reconnaissance.

Frank - We might tell the field for what parts of the country we have index sheets for and ask them to indicate priorities.

Woodward - Priorities would be very helpful to us.

Frank - There may be a number of areas which for one reason or another AAA doesn't contemplate flying in the near future. I'm thinking of areas of private land where we would like to get pictures for flood surveys but where the AAA isn't interested and other government agencies aren't going to do much flying. Perhaps by interesting county or state agencies the flood control contributions might be considerably reduced. Does the Corps of Engineers do much flying?

Woodward - Most of the Corps of Engineers flying is done under contract. The Army air crews are not allowed to take pictures unless all bids are considered too high.

Wright (to Frank) - Are you referring to commercial flying of such areas?

Frank - Yes.

Wright - That is being done all the time. Requests for photos by all agencies in the Department must clear through OIUC.

Woodward - In Florida we have a 10,000 square mile job. The state is putting up dollar for dollar. Michigan, Pennsylvania, and Virginia have also contributed to flying in these states.

Frank - Is there any way the field can get the record of flying being done by outside agencies?

Wright - By making inquiry here.

Wright - All agencies in Washington make inquiries of Board of Surveys and Maps to see if the areas are flown.

Ingersoll - Regarding cooperation with the Army on the use of pictures: we agreed to furnish photos to the Army on the damage survey. We got the survey, our photographs were used, but Army contributed one-half and maybe three-fourths of the cost of field work. The survey results were agreeable to both departments. Sometimes economy can be a boomerang. I can see a tendency all the time to cut down on contact prints. I still hold out that we should have all the contact prints we can get.

Frank - It is reasonable to expect the field to justify the requests for contact prints. If their use is to be productive field time and costs should be materially reduced.

Ingersoll - We can't justify them until after the effort is over.

Wooten - The Army is interested in establishing flood flow lines?

Ingersoll - Yes.

Ingersoll - We can't justify complete coverage of contacts on the Pee Dee Survey. Were we able to get complete coverage on Pee Dee the same thing (cooperation on damage survey) might develop here as did on the Coosa. (See statement submitted by Ingersoll on use of Photos.)

(Note: A well thought out survey work outline indicating among other things, just how contacts are to be utilized and actual field investigations reduced accordingly (as shown on the man-months work load charts) should provide ample justification).

Rogers - If we don't have all the contact prints we want we can get them for detailed areas. The local AAA offices and state agencies always have complete sets in their files. Not only the AAA but other agencies such as the Land Planning Boards have ordered them. It should be possible to borrow them.

Lehrbas - Some county agents have two sets of contact prints which have never been unwrapped. It is impossible for us to use their prints without some kind of authority. They have instructions that these pictures cannot be used by other agencies.

Woodward - This must be a bureau ruling.

Frank - Contact Washington and arrangements can probably be worked out.

Davis - Where photos are unused they're actually surplus property.

Wright - Do you know whether these photos have been accepted from the contractor? The pictures may be in their offices but if the office hasn't accepted them they couldn't make them available.

Wooten - The same restriction applies to AAA statistical data.

Bryan - We've been allowed to look over all data but could not use any particular items. We couldn't go into county records unless we could get clearance from some one above the county agent.

Lehrbas - We might first inquire of the county agents and find out if the pictures are surplus property.

Bryan - They are doing what we would be doing. We wouldn't indicate surplus property without permission.

Wright - The subject of maps need consideration. Flood control does not evidently require precise maps. I realize that the problem is one where you have to delineate your material or data on the best type of map on hand. It is possible that the method Ingersoll mentioned (making rough planimetrics from photos) will adequately serve your purpose but I believe every map issued by Department should show geographic lines if possible (e.g. at least one line of latitude and longitude) so that they can be properly placed on any map. It is so easy for a map of this nature afterwards, by going through several processes of reproduction, to create the impression that it might have been compiled from rather specific data. This may necessitate a lot of work to be done over later. Every map that isn't up to federal standards should have indicated on some place in the title the means whereby it is compiled (from mosaics, etc.).

I would like to emphasize again the matter discussed the other day with regard to the effect of relief distortion and read the following to you:

> "A matter of serious import is the effect of relief, or height of hills and mountains, as, obviously, this introduces two factors which individually, or combined, affect the accuracy of the photograph. They are respectively: (1) Scale. Since the scale of a photograph depends entirely upon the distance of the ground from the camera at the instant of exposure, it is apparent that areas of different heights will consequently have different scales; (2) Image Displacement. Image displacement radiates from the center of the photograph and is directly proportional to the distance from the center and the height of the object in relation thereto.
>
> "Another serious factor which influences the use of aerial photographs considerably is the effect of tilt. No practicable method has been so far devised whereby the optical axis of the camera lens can be maintained exactly in a predetermined direction at the time of exposure. This condition is due to instability of aircraft from which the photographs are made. The effect of this tilting of the optical axis of the lens is to introduce perspective distortions into the photograph, a condition which makes it impossible to determine true ground distances by simple measurements on the photograph. This condition would be true even if the ground were perfectly level; when the distortions due to relief differences are added to those resulting from tilt, a condition is present which complicates the situation even more than ever.
>
> "If, at exposure, the camera axis does not occupy a vertical position, that is, if it is tilted through a small angle, the image points do not all occupy, on the resulting photograph, the same position relative to each other that they would occupy had the plane of the photograph been maintained horizontal. Unfortunate as it may be that aerial photographs cannot be taken with their

vertical axis assuredly vertical, nevertheless, the effect caused by tilt can be overcome and rectified prints may be made. I will not go into this matter further as it is a very complicated and technical procedure.

"Knowing the inherent errors of aerial photographs, one can better understand their possibilities and limitations. Fortunately, by the use of stereo-plotting instruments and the extension of radial triangulation with the photographs, these effects can be eliminated and a true-scale orthographic map can be made." (Taken from: "The Application of Photogrammetry to its Related Sciences" by Marshall S. Wright, Photogrammetric Engineering, Vol. V, No. 1, January, February and March 1939 published quarterly by The American Society of Photogrammetry.)

For the interest of any of you who will be in or near Washington, the American Society of Photogrammetry is holding its meetings on January 16, 17 and 18. Very interesting papers will be presented.

The meeting adjourned.

Statement by H. B. Ingersoll on Use of Aerial Photographs.

As a result of the conference on use of photographs on Flood Control Surveys, the following impressions are submitted:

Photos may be advantageously used in varying degrees, depending on local conditions. Generally, index sheets may be used to assist in obtaining soil and erosion data. In some localities of low relief and slight variations in land-use, they may also be used for cover and slope reconnaissance surveys and "base maps". However, in most cases, where land use is highly diversified, cover and slope tabulations should be done stereoscopically.

Combining the soil and erosion data with the stereoscopically determined cover and slope data provides the areal basis for tabulation. The resulting tables of cover, soil, slope and erosion prepared for sample areas may then be applied to the area as a whole:

1. To determine approximate total plan of improvement, cost, damage, benefit, and run-off, thus:-

   (a) Plan of Improvement, a tabulation of existing and proposed land use, the cost thereof, and the location of dams and land treatments.

   (b) Damage Appraisal - for general flood damage the picture point survey or flood limits of floods of record, by stage and season, event by event, to determine average annual damage or record, supplemented by: -

(1) Spot location of structures subject to inundation and local damage due to short storms of high intensity, accomplished by analysis of the effects on the hydrograph, of present cover in selected tributaries, and the modification in the hydrograph to be anticipated. Finally, from the above, channel storage and resulting inundation.

Roadside gully damage.
Gully erosion damage.
Silt and sediment damage.

(c) Benefit analysis - the tabulations above prepared aid directly in evaluation of benefits, permitting

(1) Analysis of the integrated effect of cover on run-off before and after treatment, and assembly of data into performance by synchronization and coincident catchment analysis.

(2) The re-evaluation of charges to flood control on the basis of run-off efficiency of the various cover conversions as tabulated.

(3) Tabulated cover on the sample tributaries, stereoscopically done, now permits computation of run-off and its check against gaged run-off, thereby establishing the correctness of run-off factors used, and giving high reliability to these factors applied to revised acreage under plan of improvement.

2. The use of photo index maps to meet deficiencies in base maps:

(a) Permitting tolerably accurate drainage mapping as a basis for other type maps, such mapping being done by translating drainage and picture pointed control to the index sheets, pantographing, including control, and sliding and adjusting to the grid lines of the projection.

(b) The invaluable use of drainage maps for tributary sampling, for tributary analysis of flood performance, synchronization and coincident catchment. The above uses of tabulated data obtained stereoscopically is only possible under adequate training, instrumentation, correct technique and simultaneous field checking.

Where full use of photographs is needed and justified, some system might be developed to assure:

1. Immediate delivery of index sheets at a standard scale, not too small, quadruple.

2. Next, delivery of alternate contact prints as a field set, without stereoscopic pairs, for field use in picture point location, inundation surveys, etc. Should be on survey immediately.

3. Finally, one full set of contact prints, preferably 60% overlap.

   (a) With effective area delineated.

   (b) With drainage lines (whether intermittent or perennial immaterial) on a general scheme of omission of last 2 inches of all drainage, none included under 2 inches.

   (c) Ratioed to scale if possible. This, then gives 1 1/2 sets of contact prints, 4 sets of index maps.

Question: Should photos be used to guide the selection of critical areas or should problem areas be found first then photos ordered for them only)

It is further suggested that policies be formulated for the following:

1. Standardization of map symbols (at least general symbols as F, C, P, X, and M)

   Suggested standard delineations:

   Yellow - effective areas of contact print.
   Black - Land use outline.
   Green - Drainage divides, where required above stream gages.
   Blue - Drainage.
   Orange - Flood datum, flood plain limits, or flood limits.
   Civil and minor divisions standard.
   Orange circles - picture points.
   Standard scale 1/20000, index sheets 2" = 1 mile.
   Standard tabulation sheets (see Coosa instructions)
   Standard requirement of minimum acceptable ratio of land visited, either in field or stereoscopically, counting either of equal weight; - thus - 50%, 5% or 1% of all land must be examined either in field or stereoscopically on an area basis.

2. Standard sampling policy, such as:

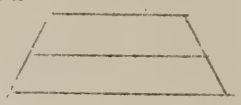
   (1) A statement in the report of ratio of area studied to total area.

   (2) Method of selecting sample.

(3) Was sample extended by simple multiplication, or within known limits, thus: - if in the sample area 6 forest cover types were broken down, and in the whole area the total amount of forest not broken down is known, the extrapolation is far stronger than if the extension is made without any general cover breakdown for limits.

Standard methods of relative area determination, including proration methods to assure good translation of relative totals to known limits (see Coosa spot grid and proposed integrating card for use instead of planimeter).

Standard type of pantograph in view of apparent inability to get projection machines: 5 piece type recommended instead of usual 4 piece.



H. B. INGERSOLL
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Note: The above represents Mr. Ingersoll's opinion only and not necessarily that of the seminar or of the Flood Control Advisory Committee and is presented as additional information on the subject.

Appendix A

PRELIMINARY DRAFT

THE USE OF AERIAL PHOTOGRAPHS AND MOSAICS

WITH PARTICULAR REFERENCE TO FLOOD CONTROL SURVEYS

The use of aerial photography is increasing greatly in connection with land management activities of various kinds. Particularly in dealing with large areas, a good set of aerial pictures enables a much better visualization of the physical characteristics of an area than is possible by simply riding over it. This is particularly true in an area where the topography is rough and uneven or where the land use pattern is patchy and diverse in nature. Since the above conditions exist in many watersheds concerned with flood control survey activities the amount of detail that can be obtained from a good set of contact prints and mosaics renders them extremely valuable on a flood control survey project, involving as it does in many cases the possibility of extensive recommended changes in the land use pattern. Their value is reflected not only in the great amount of field work than can be saved but also in the accuracy of results obtained. For example, over a large area of varying topography with a complex land use pattern, the full use of a set of contact prints enables a complete classification of such physical factors as land use, slope, the gullying stages of erosion, etc. from an office stereoscopic study. Further, such complete coverage eliminates the necessity of "factoring up" samples with the attendant possibilities of error in an area of complex nature.

This discussion is not intended to cover the extent to which pictures can and should be used, but is intended rather as a brief resume of how they may be used and what can be determined from them. It will endeavor to treat the subject more from the experiences gained from their use on a particular area rather than from their use in general. Some physical characteristics will vary in appearance on the prints throughout the country while others will remain constant. The particular area mentioned before covers a wide range of conditions including topography ranging from comparatively flat river bottoms thru rolling Piedmont hills, foothills and up to steep and rugged Appalachian mountains. The land use pattern varies from expansive areas of solid forest to a patchy chopped up pattern of cleared and wooded areas and to large areas of cleared lands. Erosion varies from none, or slight sheet erosion, to severe gullying stages, in some instances rendering the land unfit for agricultural use. Culture such as roads, buildings, towns, etc. is typical of many sections of the country.

In contracting aerial photography it is ordinarily contracted by Counties, Parishes, or some other large division. Obviously the number of "contact prints" or individual exposures, necessary to cover

(Over)

an area as large as a County is too large to allow a visualization of the entire area. Furthermore, some system of indexing is necessary in order to be able to readily locate desired individual prints or areas. Consequently, a group of individual contact prints will be fastened together and the group photographed to form a "mosaic". The entire set of prints covering a County or other area is thus divided into approximately equal parts for combining into mosaics. A common scale for individual contact prints is 1:20000 and for the accompanying mosaics approximately 2" = 1 mile. In this connection, each contact print is numbered consecutively, usually in the upper right hand corner and each mosaic is given a number. The contact print numbers appear on the mosaic, thus affording a ready index to any particular portion of the mosaic. Then by making a skeleton outline of each mosaic in its relative position with the other mosaics it becomes easy to locate, for more detailed study, individual contact prints of any particular portion of a County. By filing contact prints numerically it is a simple matter to locate those desired.

No attempt will be made here to discuss the preparation of adequate base maps from aerial pictures, although in areas where accurate base maps are lacking this can be an important function of pictures.

The contact prints and mosaics being on different scales, thus can be used to serve different purposes. In flood control survey work mosaics will be found useful for the following purposes:

1. As an index to individual contact prints.

2. As a base map upon which to locate and define the watershed boundaries of the area under study. Likewise they are very useful in delineating minor tributaries within the main watershed as an aid to hydraulic studies or the location of problem areas.

3. As an aid in obtaining a visualization of the conditions existing over a large area. By fitting together adjoining mosaics a "birdseye" picture of a large area can be readily obtained.

4. As a reconnaissance map for use in the field for various purposes.

5. For the determination of the location and relative amounts of open and forested lands.

Some physical characteristics such as soil types, refinement of slope and the lighter stages of erosion cannot be delineated by stereoscopic study. For these factors the mosaics furnish an excellent base map upon which they can be mapped in the field. This mapping is later very useful as a reference used in conjunction with more detailed study of the individual contact prints. The mosaics are also very helpful in locating the position of individual farms or other sample areas to be studied in detail in the field.

The individual contact prints can serve a variety of purposes. Perhaps their chief value lies in the delineation of the various classes of land cover and land use and delineation of areas recommended for change based upon the physical characteristics discernible combined with those obtained by field survey. They are also valuable in the detailed study of individual farms, flood plains, flood damage areas, stream channel movements, methods of cultivation, deposition, mining and lake development, road and bridge relocation, condition of forested areas and many other integral parts of a flood control survey. They can be used to advantage also in making reconnaissance field surveys, as for example, locating and mapping forested areas in which in addition to satisfactory crown canopy the stands have floor cover conditions favorable to the retardation of run-off. In this instance the floor cover condition cannot be detected through the stereoscope because of the interference of the crown canopy.

The mosaics are ready for use as received from the photographer, unless it is desired to trim a set and fit them together. There is ordinarily a certain amount of overlap on mosaics, usually only one flight or a portion of a flight of pictures. In addition there is a border or margin left blank. By trimming off this overlap and border the mosaics can be pieced together to form an unbroken picture of the entire County. Thus a sort of "mosaic of mosaics" is obtained. The individual contact prints, however, must be fitted together by so-called "effective areas" before any accurate delineation of land uses with subsequent acreage determination may be accomplished without fear of duplication. In this connection a short discussion of the mechanics of aerial photography may prove helpful.

Each County, or other division, is covered by a series of flights, usually North and South. Individual pictures are taken along these flights. For example, the photographer will start in his plane at the southeast corner of the County and fly in a due North direction to the northern boundary of the County, taking pictures as he goes. He will then turn and fly due South to the southern boundary just west of his first flight. This is repeated until the entire County has been flown. The individual pictures may be numbered consecutively through the entire series of flights through the County or they may be numbered consecutively for each day's flying. Ordinarily each County is assigned a letter and all pictures in that County designated by that letter. Thus, should any pictures become misfiled they can be identified as to the proper County by the letter. Assuming the County letter to be A, the pictures, if numbered consecutively through the entire county, would be numbered as follows: A-1, A-2, A-3---------- A-51, etc. However, if numbered consecutively by each day's flight they would be numbered as follows: A-1-1, A-1-2, A-1-3, etc. through the day's work, then A-2-1, A-2-2, A-2-3, etc. for the second day's work; A-3-1, A-3-2, A-3-3, etc. through the third day and so on until all pictures were taken and numbered. The picture number appears in the upper right hand corner of each picture and the date the picture was taken sometimes appears in the upper left hand corner.

As before noted, the County is then broken up into approximately equal parts for the preparation of mosaics. The following diagram illustrates the division of a county into six (6) mosaics:

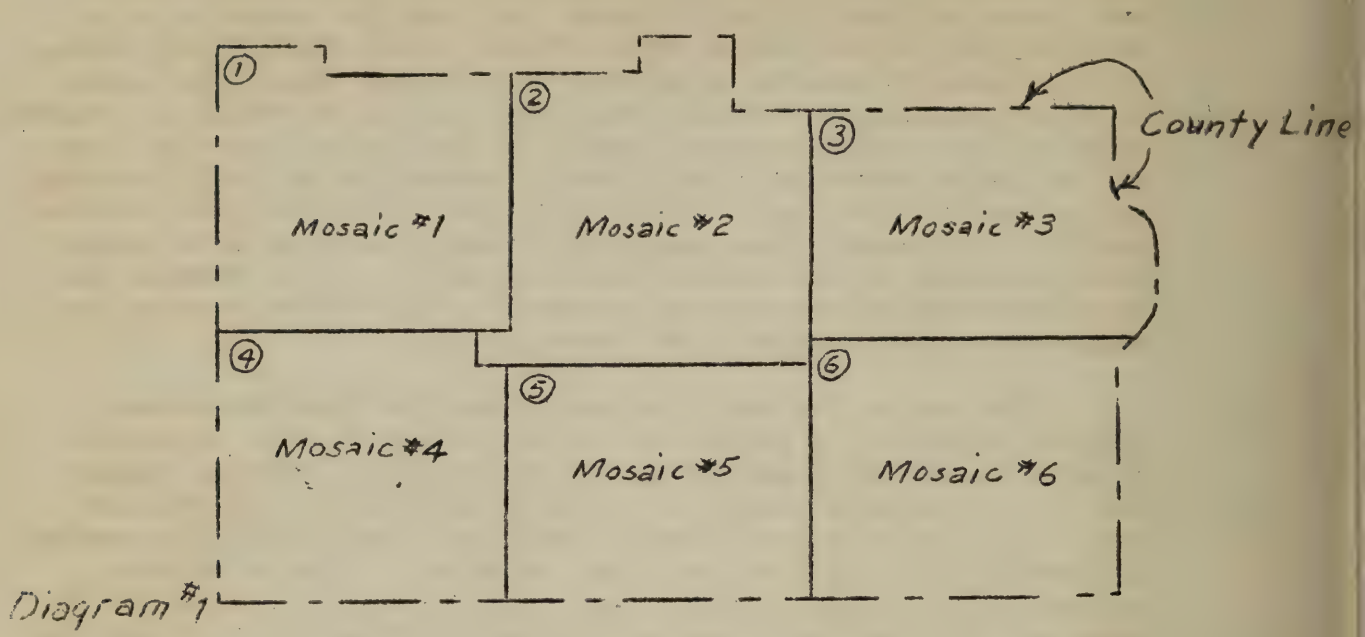

Diagram #1

Using the system of numbering pictures consecutively for each day's flight, the following diagram illustrates the composition of mosaic #6 and shows how easily an individual picture covering a particular spot in the County can be located by its number:

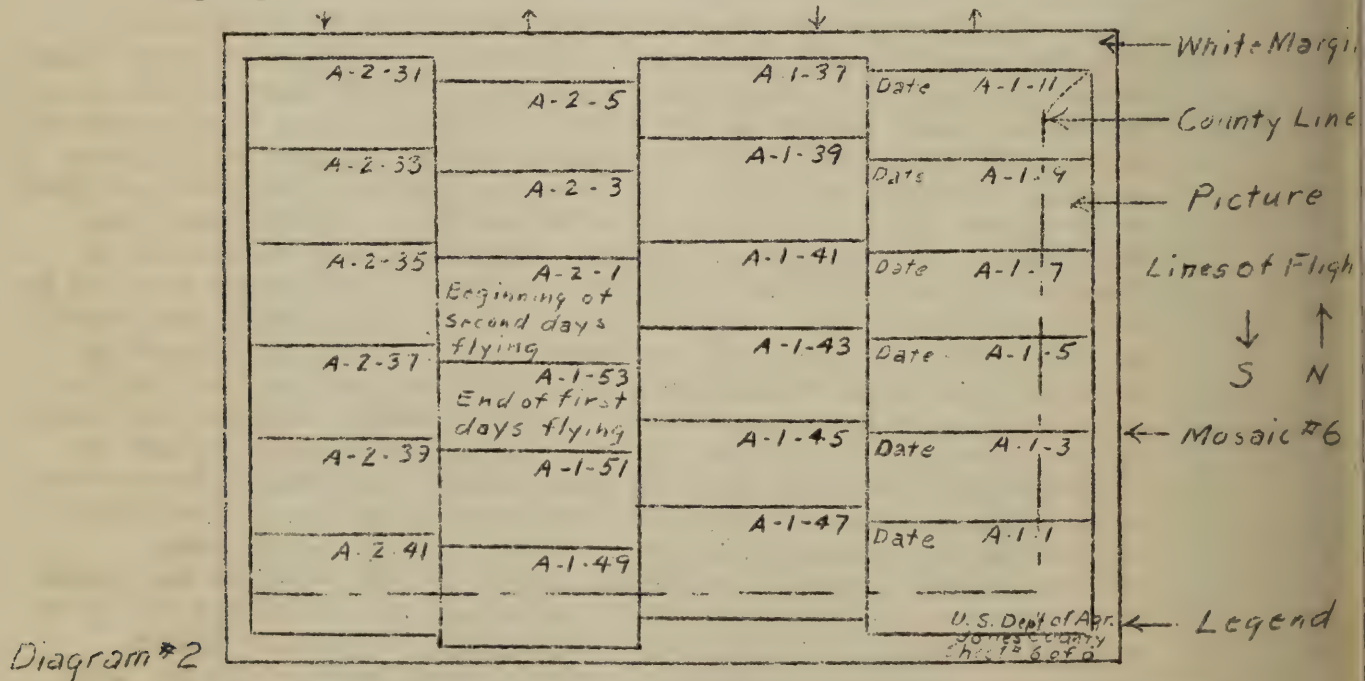

Diagram #2

From diagram #1 it will be noted that mosaic #3 lies above mosaic #6 and for this reason pictures above A-1-11, A-1-37, A-2-5 and A-2-31 are on mosaic #3, since the photographer flew to the north line of the County before returning south.

From diagram #2 it will be noted that only every other picture in the line of flight is shown on the mosaic, rather than each consecutive picture. This omission on the mosaic is due to overlapping of the individual pictures. The percent of overlap may vary with different contacts but in the case in illustration the pictures overlap by about 60% in the line of flight and the lines of flight overlap by about 30%. In other words, there is a 60% overlap north and south and a 30% overlap east and west. Thus, for mosaic purposes entire coverage of the area can be obtained by using only every other picture in the lines of flight. The following diagrams illustrate this overlapping.

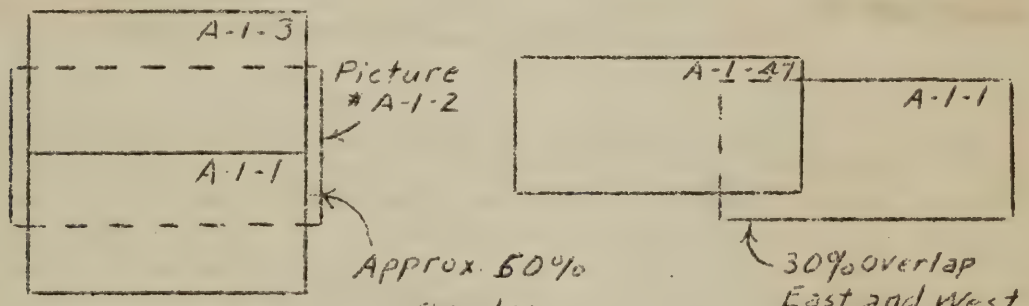

Diagram #3

It will be noted that since the overlap east and west is only about 30% it is necessary to use all flight lines to get complete coverage in the mosaic. In some instances the movement of the plane in flight may unavoidably vary east or west from the true line of flight resulting in a percent of overlap varying from the intended, in the illustration 30%. This variation is the exception rather than the rule but the occurrence is due to deflections in the plane's course.

At first thought this high percent of overlap, particularly in the line of flight, would seem to be unwarranted. However, it is done for very good reasons. Obviously it is necessary to have a certain overlap in order to assure complete coverage. For very detailed use involving land line delineations, etc. and accurate acreage computations it is necessary that this overlap be about 60% in the line of flight to eliminate as much as possible distortion in the individual pictures. Photographing to a scale of 1:20000 with an overall size of each individual picture of about 7" x 9" will result in a certain amount of distortion in the outside edges of the picture, increasing with the distance from the center of the picture. This distortion is caused by the angle at which the image (the land) is recorded on the film in the camera. In other words, that area which is photographed in a vertical plane with the film will be practically free of distortion, while the areas that photograph on a plane which meets the film at an angle will be distorted depending upon the angle. The following diagram illustrates this point:

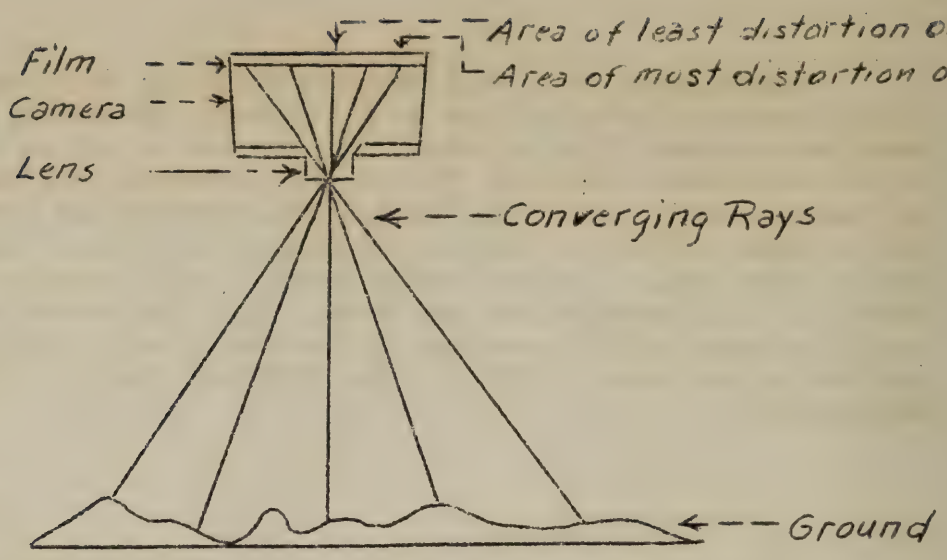

Diagram #4

The overlap on the individual pictures enables the marking off of a so-called "effective area" in the center of each picture which includes the area of least distortion. Since the overlap is greater north and south than it is east and west this "effective area" will take the shape of a parallelogram with its long axis east and west. If all the effective areas were pieced together it would result in a 100% coverage of the area, composed of those parts of each individual picture containing the least distortion. These areas should be carefully delineated and permanently marked on the pictures. Care must be taken that a 100% coverage by effective areas is accomplished but that at the same time no overlapping occurs. Then by confining all future detailed delineations, acreage computations, etc. to these effective areas the effect of distortion is minimized and at the same time it affords a simple means of control for computations, assuring full coverage of the area without duplication. This latter point is of particular importance where the use of a large number of pictures is involved.

The following is a simple method of marking effective areas on the contact prints.

1. Secure all pictures covered by a given mosaic, including the alternate pictures not actually shown on the mosaic. The pictures should be kept segregated by flight lines and in sequence within each flight line.

2. It will be found most convenient to work with these consecutive pictures in each of two adjacent flight lines at one time. These should be arranged in sequence as they appear in the line of flight.

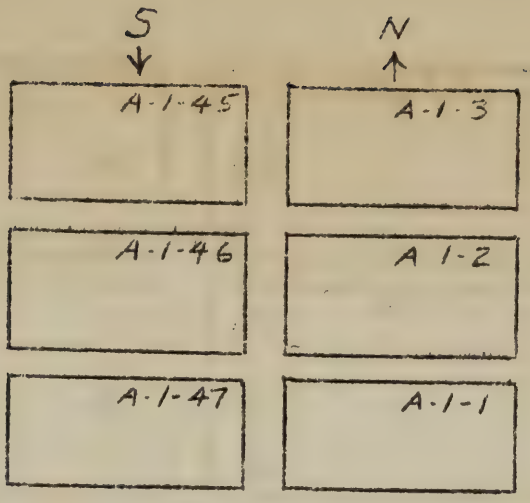

Diagram #5

3. It will also probably be found most convenient to locate the north and south lines independently of the east and west lines. On pictures where County lines appear the County line should be used as one side of the effective area.

4. In the above illustration, select in the lower left hand corner of picture A-1-1, approximately 1/5 of the distance of the entire picture from the left hand border, some outstanding picture point such as the intersection of two roads, the sharp corner of a definitely outlined field, etc. and with a dropped bow inking pen mark this point with a small circle. Then turn to picture A-1-47. This same picture point will appear in the lower right hand corner of this picture. It should be circled in the same manner.

5. Going back to picture A-1-1 another definite picture point should be selected and circled approximately north of the first point and about half way up the picture. This same point should then be circled on picture A-1-47 also. Because of the overlap this last point will also appear near the bottom of the two pictures above the ones just marked, or on pictures A-1-2 and A-1-46, and should be circled on them.

6. Then select a picture point near the top of picture A-1-1 and as nearly as possible in a straight line above the first two and circle it and also circle it on picture A-1-47. Here again because of the overlap it will appear near the middle of pictures A-1-2 and A-1-46 and also near the bottom of pictures A-1-3 and A-1-45, and should be circled on them.

7. Now select a picture point in the same manner near the top of picture A-1-2 and circle it. As before this point will be found on picture A-1-46 and also near the center of pictures A-1-3 and A-1-45, as well as near the bottom of the pictures just above them, and should be circled on all. This same process is repeated on through the entire flight lines. The following diagram illustrates this procedure.

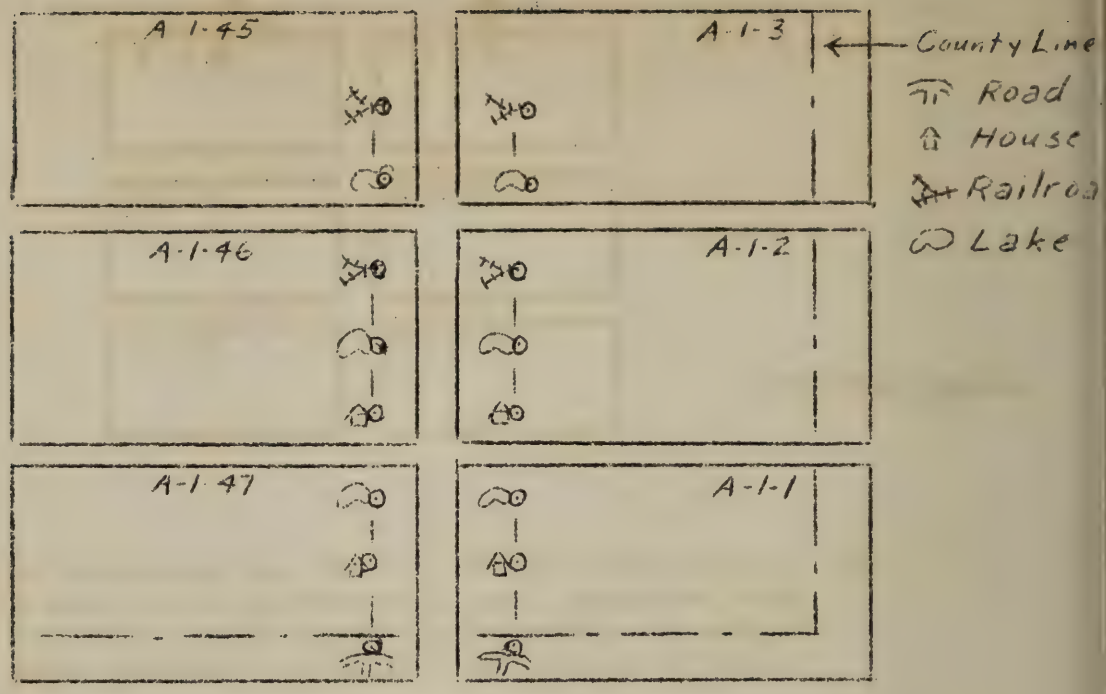

Diagram #6

8. When the entire flight lines have been completed the points thus established should be connected. Yellow drawing ink has been found satisfactory for these lines and orange drawing ink to circle the picture points. It will be noted that no lines have been established along the east side of the flight line beginning with picture A-1-1, the County line serving this purpose.

9. Next, take the pictures in the flight line beginning on the bottom with picture A-1-47 and all pictures in the adjoining flight line to the west beginning with picture A-1-49, see diagram #2, and using the same procedure mark points through these two flight lines. Flights A-1-1 and A-1-47 are now complete, insofar as point selection is concerned, since picture points have been established through both sets of pictures. (See diagram #7)

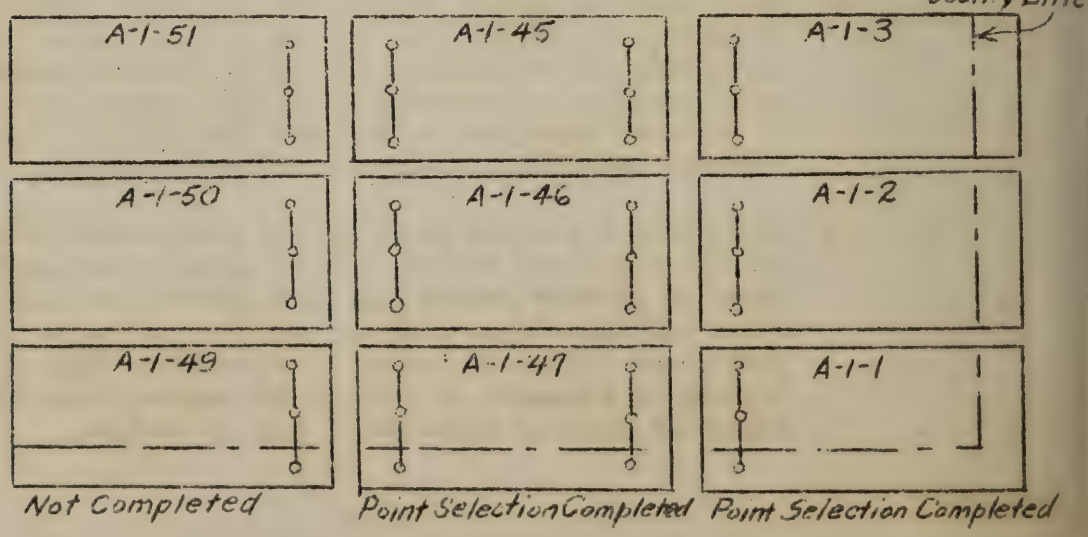

Diagram #7

Using the same procedure, go through successive flight lines westward. The last flight line on the west of any mosaic will of course join with the first flight line on the east of the next mosaic.

10. The vertical lines delineating effective areas have now been established and the horizontal lines can be established as follows:

> Here again in the illustration the County line furnishes the southern boundary. For other horizontal boundaries come in from the edge of the picture approximately 1/3 of the width of the picture and, shifting up or down slightly as necessary, draw a horizontal line that will connect two or more easily recognizable points across the picture. The resultant rectangle is the effective area of the picture. The points used for establishing this northern boundary on one picture will also appear near the bottom of the next picture above it and a corresponding line should immediately be drawn to establish the southern boundary on that picture. In establishing horizontal boundaries the only matching necessary is between pictures north and south. The same procedure is followed until all horizontal boundaries have been established.

All effective areas have now been established and future detailed work and acreage computations on any given picture will be confined within the effective area. By coming in from the edges of the pictures approximately 1/5 of the length of the picture and 1/3 of the width to establish the vertical and horizontal boundaries respectively, the overlap between adjoining pictures is divided about evenly between the pictures. The following diagram illustrates completed effective areas on adjoining pictures.

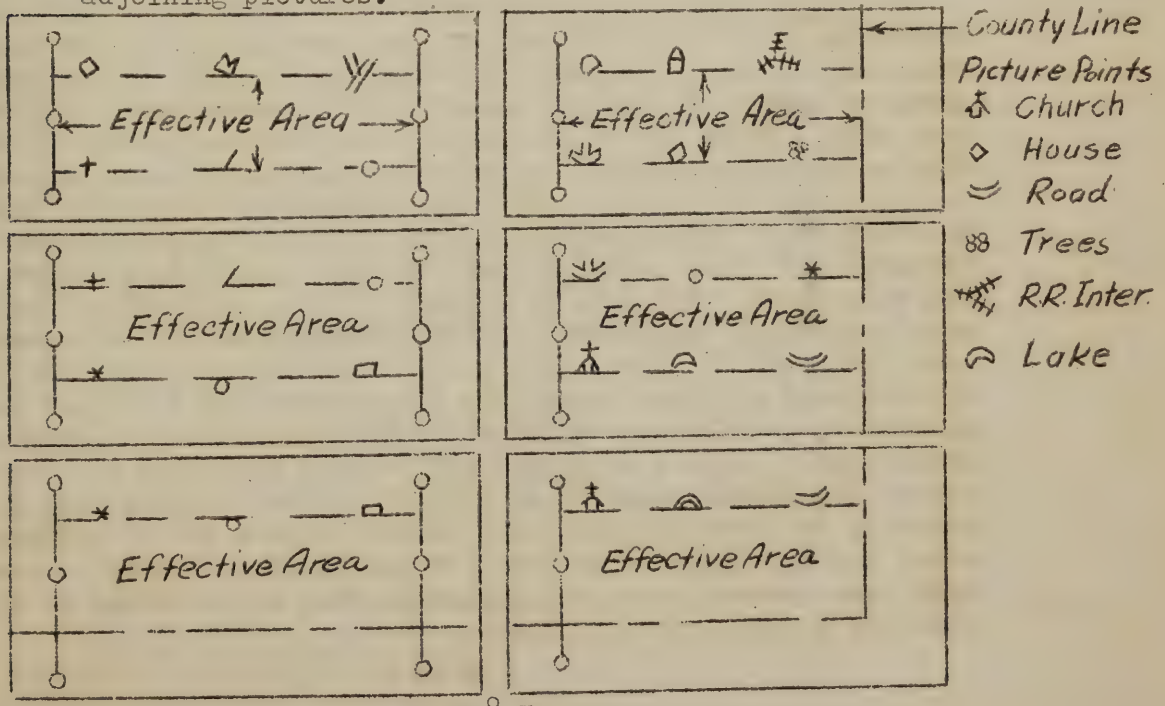

Diagram #8

It has been found that two men working together delineating effective areas, one to locate and mark picture points, and one to ink in boundary lines, is the most efficient procedure.

Now that effective areas have been delineated on all contact prints they are ready to be used for detailed study, usually with the aid of a stereoscope. In using a stereoscope it is necessary to use adjoining pictures since the principle involved depends upon using two photographs taken at slightly different angles so that the photographic images after passing through the lens of the instrument will reach the eyes of the observer in such a manner as to give relief to objects on the picture. After two pictures have been placed under the stereoscope they must be adjusted until just one image appears and that image shows definite relief or third dimension. This adjustment is effected by moving the pictures up and down or sidewise until the correct image is secured. After the correct focus is once obtained both pictures can be moved simultaneously, or in unison, to bring into the best relief any desired spot on the picture.

As before stated, possibly the chief value to flood control surveys of a stereoscopic analysis of contact prints is the ability to recognize and delineate, without the necessity of a field survey, various types of land cover and land use and by recognizing certain physical characteristics be able to recommend best future uses. The following will attempt to describe the appearance under the stereoscope of some of the recognizable physical characteristics.

The first thing noted is probably the striking contrast between forested and open lands. With a little practice and actual checking in the field many variations of each class can be recognized on the pictures. Insofar as woods areas are concerned the following are some of the more common variations recognizable:

1. Well stocked lands where the crown canopies of the trees are so dense as to prevent any of the ground showing thru the trees. These can be either hardwood or evergreen stands. If the stand is composed mostly of pine the area under the stereoscope will show up very dark. There may be very small open spaces, caused by the absence of a tree, where a patch of ground can be seen down thru the trees, however, in a well stocked stand the area will have a uniformly dark appearance which will be almost black on good pictures. In pure stands of well stocked hardwoods the area under the stereoscope will show up a solid uniform gray color having a very deep thick appearance. In well stocked stands of hardwoods mixed with pine the area will have a deep uniform gray color interspersed with numerous black dots (pine trees) if the pines are scattered, or splotches of black if the pines occur in groups. Occasionally patches of ground can be seen down thru the trees where either individual hardwood or pine trees are missing. One thing to remember in distinguishing well stocked stands is the uniformity of color and the depth of relief. If the stand is old and mature it will have greater depth of appearance than if the stand is composed of younger, shorter trees.

2. The second variation in forested lands as seen under the stereoscope are understocked stands where due to fire, cutting, tornado, disease, etc. the death of numerous trees has left the crown canopy of insufficient density to completely cover the ground. If the stand is composed of practically all pine the area will have a gray mottled appearance, the gray will have no depth due to the fact that it is the ground from which trees have been removed, while the darker portions, which are the pine trees, will show up with considerable depth depending on the height of the trees. In stands of understocked hardwoods the area will have a slightly uneven gray appearance. Close scrutiny will show that the gray portion without relief is the ground and that the slightly darker gray portion with relief is the scattered hardwood trees. The depth of the relief will again vary with the heights of the individual trees in the stand. In understocked stands of hardwoods mixed with pines the area will appear as a combination of two conditions just mentioned. In other words, the ground will show up as gray without relief, the pines as dark almost black spots or patches with varying relief and the hardwoods as gray dots or patches with varying relief.

3. The third variation in forested lands are the areas which have been very closely cut-over and burned and which now support only a stand of scrub oak and weeds of varying degrees of density. If the area has a thick cover of scrub oak and grass or weeds it will have a medium gray, very fuzzy appearance with the depth of relief being very shallow. If scattered black dots having shallow relief are noted these are young pine trees which have managed to establish themselves and survive on the area.

If the cover of scrub oak is of medium density the area will have only a moderately gray fuzzy appearance with a larger volume of gray (the ground) showing up with no relief. Likewise an area with a low density of stocking of this scrub oak will show up as an almost uniform gray without relief with small dots of gray having moderate relief, the latter being the scattered scrub oak cover. Again, if scattered black dots are noticed in the area they represent small pine trees which have managed to withstand burning and establish themselves.

4. The fourth variation is forest plantations. It will be impossible to distinguish very young plantations of either pines or hardwoods, consequently these areas will appear as open lands of the class plantable. However, plantations which have been established for a period of approximately ten years or more will have a very characteristic appearance. Pine plantations appear as closely spaced black dots with relief, this relief depending on the heights of the individual trees. Occasionally dots will be missing which indicates the absence or death of a tree. Hardwood plantations appear as closely spaced gray dots having relief and again the depth of the relief will be determined by the heights of the individual trees.

5. Natural young growth may be mentioned as a variation, however, these areas will have the same appearance as well stocked older stands with the exception that the depth of relief will be more shallow. In second growth and mature stands from which fire and intensive grazing have been excluded there is usually a very heavy cover of young natural reproduction, weeds, ferns, grass, etc. Since the crowns of the older trees prevent a view of the ground under them and since this vegetation is very small there is no way of studying the actual conditions on the forest floor by means of the stereoscope. Consequently, if it is desirable to know as to whether or not there is young reproduction in the forest or whether or not fire and grazing have destroyed the cover of the forest floor, one must make a survey of this condition in the field.

Just as several variations in forested lands can be recognized under the stereoscope, there are certain distinct classes of open lands which can be easily distinguished.

1. The first class includes lands under all types of cultivation.

   a. Cultivated fields which occur in the river and stream valley areas have a very smooth uniform light gray appearance. The individual fields are separated by dark narrow lines which vary from straight to any degree of curvature. These lines mark the point where tilling of the individual field stopped and the dark color is due to the presence of grass, weeds, small trees or other vegetation. A very straight dark line separating fields usually indicates a property line. In some fields there may appear areas which are a darker gray than the surrounding field; this indicates a low damp or poorly drained portion on which grass or weeds are making rapid growth. A meandering very light gray band having varying depths of relief and usually bordered on both sides by a dark narrow strip of vegetation indicates a stream running through these bottomland fields. If it is a large stream or river the band of vegetation or trees will be of varying widths due to the fact that at many points along a large stream cultivation to the very edge of the river or stream is impossible. If narrow white ribbons running in straight lines or with uniform degrees of curvature are noted these indicate roads traversing the bottomland fields. Since these bottomland fields occur on level or very moderate slopes little or no relief will be apparent under the stereoscope.

   b. Cultivated fields which occur on gently rolling to moderately steep slopes have a white appearance due to the fact that the absence of adequate moisture prevents an appreciable growth of grass and weeds during the interval between tilling. As under "a" dark lines separating fields indicate field boundaries or property lines and they appear dark due to the presence of

vegetation. A series of more or less uniformly spaced dark lines following the contours indicate terraces on which is growing grass or other vegetation. If these terraces are high they will have shallow relief. However, the ordinary terrace will have very little or no relief under the stereoscope. Streams will have much the same appearance as under "a". However, they will meander less noticeably and usually have less vegetation along the banks.

c. Cultivated fields on very steep slopes have a very white appearance due to the fact that sheet erosion is continually removing a small layer of topsoil and thus prevents the establishment of large quantities of grass or weeds. Terraces will be apparent and in some cases gullies which will be discussed later. Streams will be small and usually have deep channels which have considerable depth of relief and vegetation along these stream banks will ordinarily be sparse.

d. Closely spaced dark narrow straight lines running across a field indicate corn, cotton or other heavy bodied crops in furrows. A very uniform appearance resembling a smooth blanket indicates hay or other forage crops of this nature. Small light gray dots spaced at fairly regular intervals indicate hay or forage cut and stacked for curing.

e. Orchards are considered as cultivated land and appear under the stereoscope as an area of dark dots, having shallow relief, with very close uniform spacing. Since orchards are likely to occur most anywhere in an area it is usually safe to consider an area with the above description as an orchard of fruit trees.

2. The second class of open lands are those which have been out of cultivation or idle for several years.

a. Idle fields occurring on gently rolling to moderately steep slopes will have a very dirty gray, cut-up appearance. Scattered through this dirty gray color will be very white patches of irregular shapes. The dirty gray color indicates broom sedge, grass and weeds, while the white patches are spots of badly eroded bare earth on which vegetation has not been able to establish itself. On some idle areas small scattered black dots or larger patches of black indicate that small pine trees are establishing themselves on the area. Long white lines having depth of relief indicate gullies in the abandoned fields. These gullies will be discussed later.

b. Idle fields or areas occurring on steep slopes vary from the above dirty gray appearance, if grass and weeds are established, to an extremely white color if erosion is in a severe stage. If sheet erosion is severe the area will

have a desolate washed-out appearance; if active gullying is present, long white fingers of varying depth of relief and width will be seen running down the slope. The entire area may be covered with these fingers. The presence of these gullies immediately indicates that cultivation is not in progress and that the land is idle or has been abandoned recently.

3. The third class of open lands are those being used for pasture. This class usually occurs in the areas of level to gently rolling slopes and have a very smooth uniform dark gray appearance. The boundaries of land in pasture will usually be straight lines since most areas of this class are surrounded by fences. The intensity of the gray color characteristic of pasture land is between the dirty broken gray of idle lands and the very smooth uniform light gray of cultivated lands located in stream valley areas. Numerous black dots having relief may be apparent and these indicate scattered pine trees. In some instances on moderate slopes there may be small white patches showing up in the pasture lands. These are small areas which have been badly eroded and upon which vegetation has been unable to establish itself. Also there may be a few long white fingers which indicate gullies. Upon more careful scrutiny of a field in pasture narrow white ribbons may be seen traversing the field. These are trails made by animals and are consequently a great help in making sure of the fact that the land actually seen under the stereoscope is pasture. A group of farm buildings are easily located under the stereoscope and since most farmers desire to have their stock near their barns, areas under the stereoscope having the above characteristics and located near a group of farm buildings can usually be safely classed as pasture lands.

4. The fourth class of open lands includes all lands not in cultivation, idle, or pasture. This is known as miscellaneous lands and include the following with their certain definite characteristics:

   a. Cities which are distinguished by rows of houses, concentration of railroad tracks, large manufacturing developments, well defined streets and numerous other features which can be easily recognized as familiar objects in a city.

   b. Small towns, villages, or settlements characterized by the presence of a large school building surrounded by open land and several rows of houses. Numerous roads will also be found to concentrate at such points on the picture.

   c. Main highways of concrete, macadam or gravel which appear as narrow white ribbons on the picture. These main highways usually have broad sweeping curves and

run in long straight lines wherever possible. They will have definite relief when built on fills or will appear sunken when passing through cuts. Country clay roads appear as very narrow white ribbons with sharper curves and practically no relief since they are not built on the same uniform grades as main routes of travel and consequently have fewer cuts and fills. Bridges over which highways cross medium sized to large streams can be distinguished due to the depth of relief of the stream under the bridge and in many cases due to the relief of the fills on which the road approaches the stream.

d. Railroad right-of-ways and tracks appear as dark gray ribbons traversing the picture, curves are broad and sweeping, there will be long stretches of straight roadbeds. Since the track is laid on a very mild uniform grade there will be cuts through hills and ridges, and narrow valleys and streams will be filled or bridged. These will all have relief and consequently make the delineation of railroads under the stereoscope very simple.

e. Clear lakes and large bodies of water will have a very level smooth medium dark gray appearance. It is easy to follow this dark gray color around the contour which makes up the shore line; also, if the lake is the result of a dam across a stream this dam can usually be located due to the depth of relief of the stream channel below the dam. If the water is muddy in the lake it will have a light gray almost white appearance, resembling a cultivated field.

f. River channels appear as medium dark gray bands meandering through an area; they are usually fringed on both sides by a dark almost black border which is vegetation and trees growing on the banks. The channel will have moderate relief, unless at flood stage, since the level of the water is below that of the surrounding land.

g. Mine pits appear as white patches varying in depth of relief in accordance with the depth of the pit. Very deep pits will have great depth of relief. Mine washes also appear as very white badly eroded areas.

In addition to the various classes of wooded and open lands which can be distinguished there are certain other factors and conditions applying to these lands, delineation of which under the stereoscope must be positive and reasonably accurate:

1. Gullies, as stated before gullies appear on the picture as white narrow fingers of varying lengths and depths. If gully erosion on an area is mild there will be only a few very small white fingers running down the slope; if erosion is serious the entire area may be covered with these. Since it is possible to place a grid over the picture that is under stereoscope

study and determine the number of acres in a gullied area, it is possible from this to count the number of gullies on this same area and calculate the number of gullies per acre; also, the gullies have varying relief dependent on their depths and from this it is possible to estimate the approximate average depth of the number of gullies present on any acre of seriously gullied land. The seriousness and depth of gullying is dependent on the type of soil and slope of the area as well as the condition and type of cover. Determination of cover has been explained under the land classes.

2. Slope can be distinguished due to the relief available on the pictures under the stereoscope. Level, gently rolling, moderately steep, steep and very steep slopes can be readily determined once the pictures have been correctly focused under the instrument.

3. Soils classes or groups can not be delineated under the stereoscope since their classification depends on a combination of factors available only by study of an area in the field.

4. Terraces and the characteristics by which they are recognized have been discussed under open lands.

5. Buildings, as stated before, are easily recognized due to the relief caused by the heights of the structures.

6. Rock outcrops, usually found on top mountain slopes, appear as medium gray rugged, broken-up areas, if the rocks are large there will appear a certain definite depth to the relief caused by the rocks jutting out above the surrounding land.

7. Flood plains occur along all streams that flow through areas that form level valleys on one or both sides of the stream. On small streams in the foothills this flood plain may only occur at certain intervals and then be very narrow. In level country and along larger streams and rivers the flood plains may be very broad and run for many miles along one side or both sides of the stream. This flood plain is the area covered by water when the streams, due to heavy or prolonged rains, rise and flow over their natural banks. Since the plain is always very level and at approximately the same elevation as the river bank it is covered by high water to a point where the slope begins to rise sharply. This flood plain when tilled is classed as open land under cultivation and under the stereoscope has the very smooth uniform light gray appearance described under the first class of open lands. One additional characteristic distinguishes the flood plain from other cultivated land lying in river and stream valley areas. The land over which the flood water flows will have a

scarified appearance. Under the stereoscope this will appear as closely spaced light and dark colored lines running parallel to the direction the stream is flowing. These lines of scarification will be apparent in cultivated fields, idle and pastured lands lying within the flood plain. Forested lands are occasionally found in the flood plain and they have the same appearance as forest areas in any other location, since the canopy of the trees prevents a view of the ground. Occasionally sand or gravel deposits can be located in the flood plain. Such deposits have a lighter gray color than the surrounding areas. In outlining a flood plain of a stream on a picture under the stereoscope it is necessary to go out from the bank of the stream to where the slope begins to rise noticeably and then to include in the flood plain any of the area just covered that is marked with these lines of scarification. In the delineation of flood plains there are often present numerous white lines running vertically into the stream. These are gullies and usually occur on a slope near the stream which is high enough to be above the flood plain. Small meandering black lines running across the flood plain and connecting with the stream or river bank, indicate very small streams with such a heavy cover of vegetation on the banks as to make the water invisible.

In the classification of wooded and open lands and the delineation of land uses under the stereoscope it is necessary to be familiar with all the information that is available on the picture and to accurately interpret the various characteristics which have just been discussed. After a certain amount of familiarity with the use of the stereoscope in the delineation of land uses is gained considerable speed can be developed in this work. When delineation is first begun several pictures should be carried to the field and all the forested and open lands outlined as it actually exists on the ground. This forest and open land should at the same time be designated with its proper classification, such as well stocked wooded land or cultivated or idle fields. Then the pictures should be placed under the stereoscope in the office and a detailed study made of these various land classes as they appear under the instrument. Note in detail the characteristics that make the idle field always appear different from the cultivated fields, also the differences in appearance between the well stocked and cut-over forested areas. Next take several pictures in another location and delineate on the photographs under the stereoscope all the various land classes. When several have been completed carry them to the field and make a detailed check of your work. If idle land has been classed as cultivated, determine what characteristics on the picture led you to the decision, check these on the ground on the particular area in question so that the mistake will not occur again. Make a close check of your estimation of slopes, number of gullies per acre and their average depth and after the office-delineated photographs have been completely checked begin work on others in the office using the stereoscope. At intervals in the work, take several pictures to the field and repeat the described process of checking. In this manner the percent of error in the actual delineation of land uses will always be small and the pictures worked under the stereoscope can be used with confidence in any report.

Pictures taken on the scale of 1:20000 will average about two square miles per picture falling within the effective area. After the delineator has become familiar with the use of the stereoscope and has confidence in his delineation and ability to recognize and interpret the numerous characteristics of the various land classes, he will delineate on an average of from 10 to 12 pictures a day. This is an average of approximately 22 square miles or about 14,000 acres. Pictures covering areas that have been badly chopped-up due to the cultivation of many small fields, the abandonment of numerous others and the presence of forested areas in all conditions will be much more difficult to delineate and the acreage worked per day consequently reduced. On the other hand, pictures covering areas principally in forests or in large well planned farms, and where the slope, erosion and soils are more or less uniform will delineate with great rapidity and as many as 20 pictures can be completed in a days time.

After the pictures have been delineated in pencil and the land use symbols placed inside these various classes of forested areas, fields, miscellaneous lands, etc., the entire picture is inked, using black pigment ink. Pigment ink is used because at any time it can be dampened with water and removed from the photograph. After inking the picture is ready for acreage calculation.

Several methods of acreage determination are available -- by planimeter or the use of modified grids. In computations of this nature where large uniform areas are involved the advantage usually lies with the planimeter, but where the land use pattern is complex and chopped up into many small areas the advantage lies with the grid. Planimetering a great many small areas is laborious and time consuming and conducive to error in reading the planimeter vernier. It has been found advantageous to use a modified grid for these smaller areas. Consequently, the large, uniform effective areas are planimetered and the smaller areas grided. When acreages have been computed the sum of the parts must be balanced against the total effective area and adjusted if necessary. They are then tabulated on a card record form. The use of the modified grid for the smaller areas has been found much faster than planimetering and close checks have demonstrated sufficient accuracy. A transparent celluloid sheet the size of the picture is laid off into ten acre grids, made of course to the scale of the picture. A dot placed in each quarter section of each grid, resulting in four uniformly spaced dots. Each dot thus represents $2\frac{1}{2}$ acres. By placing the transparent grid over the picture, counting the number of dots in any given area and multiplying by $2\frac{1}{2}$ the acreage of that area is obtained.

There are two types of stereoscopes most generally in use, the "eyeglass" type and the large binocular type. The former is merely two magnifying eye glasses fastened eye width apart on a block of wood. This block is supported on an upright stand and can be adjusted up or down to obtain focus. The pictures are then moved back and forth under the glasses until the proper position is

obtained and relief appears. This type gives high magnification and bold relief. However, a rather strained position is necessary in their use and, due to the high magnification and the fact that the pictures cannot be fastened down in a horizontal plane, they ordinarily produce considerable eye strain. This type is excellent for very detailed study of small areas, however, and in this respect surpasses the binocular type.

The binocular type is a large instrument supported on three legs. The image from the pictures hits two mirrors placed similar to those in a pair of binoculars and then travels through lenses of rather low magnification to the eyes. This type does not give as high magnification or as bold relief as the eyeglass type, but is generally easier to use. It can be placed on a stand having a 45 degree angle and used without neck-strain. The pictures can be placed in tin slides, thus remaining flat and eliminating much eyestrain. It also affords a larger field of view without the necessity of moving the pictures.

APPENDIX B

PRELIMINARY INSTRUCTIONS FOR VEGETATION TYPE MAP AND CULTIVATED LAND CLASSIFICATION IN CALIFORNIA FOREST SURVEY.

(By Office and Field Interpretation of Aerial Photographs on 1: 20000 Contact Print Scale)

Introduction

Natural vegetation types as defined by broad vegetation type elements and broad coniferous age classes will be outlined and designated by symbols on overlays superimposed over contact photographic prints. Broad cultivated land classes will also be outlined and designated. No types or classes will be outlined below fixed minimum acreages set for the map scale. These minimums are discussed below. Only those broad type elements within an outlined type of natural vegetation which apparently form 20% or more of the total crown cover within such a type will be indicated with type symbols on the overlays. Within a type unit of natural vegetation only those age class components of the coniferous element which apparently form 20% or more of crown cover within such a type element will be indicated by symbols on the overlays. Thus pure stand types and mixed stand or mosaic types will be recognized. In mosaics the elements are listed in decreasing order of dominance.

Cultivated lands will be designated only with the proper use symbols, i.e. the 20% crown cover rule used in classifying natural vegetation does not apply. Such land classes within broad cultivated belts will not be outlined below the upper fixed minimum acreage set for map scale, although such small subdivisions if they are a conspicuous part of the land use pattern may contribute to the symbol designation of the large cultivated area which is outlined. The designation for such a mosaic of cultivation should indicate all of the major land uses on that area.

I Office Procedure & Technique for Type Interpretation from Aerial Photos

A. Preparation prior to Type Interpretation

Type outlining should be done for every contact print on each flight strip. Two overlays (acetate base) will be mounted on each photograph before outlining begins. Overlays should be fastened to the prints with scotch tape, one at each narrow edge of photo so they may be overlapped one over the other with buffed side up to facilitate outlining. After these are taped in place the collimation lines which appear on photographs should be inked in black on each overlay to provide orientation points. One overlay should carry designation of "Broad Types", the other "Types by Species". Number of photo and initials of interpreter should also be shown on each overlay.

(Over)

Next plot centers of overlaps of adjacent prints in green ink. Outlining for each print will be done only for area between these tie-in lines. These tie-in lines, which enclose the effective work area, will ordinarily be obtained from the work agency responsible for the compilation of the base map. By using these same effective areas we can insure accurate ties with the base map when the photographic type detail is projected onto this map. We will obtain the effective areas for photographs of national forest units from the Division of Engineering, Forest Service, by simply tracing the boundaries of these areas from the work prints in that division to our overlays. The collimation marks will provide tracing control.

In cases where the base mapping agency has not determined the effective areas and tie-in boundaries prior to our type outlining the following procedure will be used: In making tie-ins first overlap the photos by orienting areas in common to each photo. On overlay for one print draw a straight line approximately through center of overlap. Match line just drawn over one print to culture and topography on adjacent photo and draw a corresponding line in short segments on overlay for overlapping print to approximate location of first line. The second line will obviously not be quite straight except in those rare cases where consecutive photographs of flat country have been taken without plane tilt and thus without distortion of relief. For type map purposes, however, the ties made in the above fashion will be satisfactory.

B. Type Interpretation - Procedure

The bulk of office outlining will be done on the broad type overlay, on which broad type elements and age classes will be shown. For this study purpose the D-10 low-power stereo will usually give enough detail. Use the D-10 hi-power only for doubtful types. If the hi-power is used for all type interpretation the extra time spent per print will cut down progress because of the narrow field of stereoscopic view given by this instrument. Naturally all overlapping photos may be used for type study but outlining should only be shown on the central or effective portion of each print. Boundaries may be sketched directly upon the broad overlay but boundaries may be red penciled directly on selected prints first, if in judgment of operator the overlay cuts down too much light. However, show nothing but pencil boundaries directly on prints. All symbols and boundaries should be red penciled, then inked in violet on overlay before field work begins. Symbols should all be oriented to read when photograph is oriented with N edge up. If corrections are made on overlays during outlining use pencil eraser for removing errors. This form of erasure will easily remove both pencil and ink from the acetate base. Never use knife or other sharp instrument for erasures on overlays as permanent scratches invariably result.

If any boundaries due to species differences alone are obvious to office analyst they should be penciled on species overlay, not on broad overlay.

Inked copies of all broad overlays should be made on tracing paper prior to field work. The type analyst should turn original overlays over to designated assistant who will prepare copies and check broad overlay tie-ins prior to field work. These copies will be retained in the office as permanent records for comparison with broad overlays after completion of field checking to determine accuracy and scope of initial broad type interpretation. These checks, it is hoped, may increase the accuracy of initial office interpretation as the personnel gains more experience.

Before field work begins, all broad type boundaries will be traced in violet ink onto the species overlay but only species symbols shown thereon and none of these by office judgment unless the office interpreter is quite sure of the same. Where the office interpreter has good reason to believe that types contain certain species he should pencil their symbols in blue on the overlay as reminders for field verification.

Tables of broad type, age class elements, and cultivated land classes with symbol designations are shown below.

Broad type elements	Symbol
Conifers	C
Hardwoods	H
Shrubs or hardwoods of shrub size	S
Grass 1/	G
Meadow	Md
Soil, Litter, etc. 1/	B
Rock	R

1/ B will also be used to designate the usual litter-soil-herbaceous combinations which occur in forest openings. G will be used only for the heavier stands of herbaceous vegetation found on large clearings or natural grassland areas.

Broad-age classes (1) (in coniferous timber)	Symbol
Reproduction and poles	1
Young growth sawlog size	2
Old growth or mature	3

(1) A line over any symbol indicates a dominance of culls in that class; thus $\bar{3}$ = mature but culls. This cull condition to be determined in the field but to be shown on broad overlay.

Broad Classes of Cultivated and Urban Lands [1/]

	Symbol
Haylands and Grainfields; Irrig. Meadows	A
Orchards, deciduous	O
Vineyards	V
Truck Crops and miscellaneous	Cu
Residential	Res
Industrial	Ind

1/ This classification may be expanded upon in certain regions where the photographs insure accurate office interpretation of classes not listed here. Until the mapper is given instructions to the contrary, he should adhere to the above classification.

C Guide for Mapping Broad Types from Photographs

Map down to fixed lower minimum acreage* any contrasting types (a contrasting type defined as having no element in common with any adjoining type.) However land use classes within broad cultivated belts will be considered as non-contrasting as indicated in the introduction. Map down to fixed upper minimum acreage* any non-contrasting type.

*Suggested fixed minimum sizes for contrasting and non-contrasting types on various base map scales are:

Map Scale Publication Base	Minimum size Contrasting Types	Minimum size Non-contrast Types
1" = 1 mile	40 acres	160 acres
2" = 1 mile	10 "	40 "
3" = 1 mile	5 "	20 "
4" = 1 mile	2½ "	10 "

Most of the work in the near future premises the use of contact prints of a scale 1:20,000 (approx. 3" = 1 mile) but the types outlined thereon will probably not be presented on a base map of a larger scale than 2" = 1 mile. Therefore the size guide for outlining type areas will be 10 acre and 40 acre minimums for contrast and non-contrast types respectively as indicated in table above. Recognize only the following exceptions to this rule: all cultivated and meadow types of less than 10 acres in size will be indicated in place by symbols without type boundaries on the broad overlay. For these designations use [X] and ↓ symbols, respectively, shown in violet ink. Also no type boundaries should be drawn to subdivide an area into type units below 160 acres in size merely to show differences in relative order of elements if exactly the same elements are dominant over the entire area. For example, A (CH 32) type would not be separated from an (HC 32) type unless each type equals 160 acres in size or over.

Where types must be grouped because they fall below fixed minimum size they should be absorbed into most closely related contiguous type. This will necessitate a reinspection of some areas on photographs when several small types are grouped since the symbol designation for the grouped type may not be the same as for any of the small types which it comprises.

Where order of symbols does not indicate whether trees (C / H) are more or less dominant than all other type elements indicate this by an overline where trees are most dominant and an underline where trees are not so dominant. Similarly in cases where order of symbols does not so indicate, show whether conifers are more or less abundant than all other elements. Use / after symbol list where conifers are dominant over all others and where conifers are not so dominant use - .

In broad vegetation type analysis when a small type is absorbed into a larger type because of insufficient size of the former the question will often arise as to which of several contiguous types is most closely related to the small type in question. Obviously if a small type below the minimum size is surrounded by a larger homogeneous type it is merely absorbed by the large type. However, several contiguous types may have the same number of elements in common with the small type and consequently on the basis of common elements the small type might be thrown to either of the larger types. In cases of this kind, however, the analyst will bear in mind the major use objectives of the broad map. In order of priority these main objectives are (1) to show the location and condition of coniferous timber stands as defined by density and age class groups, (2) the types with grazing values as shown by the grass symbol, and (3) the character and extent of types which are mainly valuable for watershed protection. Another major objective, that is the segregation of types for fuel hazard ratings, will be assumed to have been fulfilled if the previous objectives are attained.

The Age class groups within coniferous timber stands have already been mentioned. In addition to this the broad type analysis is aimed to give a density classification for conifers divided into four broad groups: i.e. types non-stocked, poorly stocked, medium stocked, and well stocked with conifers. These will not be indicated as such on the overlays but the broad type symbols will be interpreted to give this classification from the finished map. For example where x = any other type element excepting C or conifers, these density groups would be interpreted as follows:

Type Symbols	Density Stocking(conifers)
x, xx, etc.	= Non stocked
xc, xcx, cxx- etc.	= Poorly stocked
cx, cxx / etc.	= Medium stocked
c	= Well stocked

Thus when the analyst must decide between several possible groupings for a small type he should group that type with the larger contiguous association which gives the closest approximation of first, the proper density and secondly, proper age class for conifers in the small type. If several of the alternative groupings will give the proper coniferous picture the difference in grazing values should next influence the type grouping. Finally if the grouping is still optional the analyst should throw the type in question to the most closely related watershed protection type. In general the density and size of all vegetation determines the groupings within this category.

Typical examples of type grouping alternatives.
(Encircle indicates proper large type into which small type should be absorbed.)

Small type	Alternative Contiguous large types
CG 32	(CS 32)
	SC 32
	HC 32
GS	HS
	(GH)
	HG
SH	H
	BS
	(S)

As the above examples indicate, a study of relative element order within small types when combined with a consideration of major map objectives will provide the key for appropriate type groupings in even the most debatable cases.

The examples just given do not take into consideration an important point mentioned previously, i.e., that whenever types are grouped the final symbol designation applies to all elements within such grouped type. Specifically in the first example the addition of the CG area might contribute enough G to the absorbing type CS to give an approximate 20% crown cover of G in the combined type. The combined type in such a case would logically be designated as CSG.

II Field Technique - Type Mapping with Aerial Photos

A. Field Equipment: All contact prints for mapping area with broad office overlays and species overlays attached. Species list with symbols obtainable at type map Herbarium. B-10 low and hi-power stereoscopes with field mapping board; pencils, inks and other drafting supplies; binoculars, tatum and other aids necessary in judgment of field mapper.

B. Procedure: Field work should be well planned to give greatest area coverage with a minimum amount of time. The mapper should bear in mind that a less intensive field check will be necessary when aerial aids are used than under ground procedure alone. As he becomes more familiar with the country and obtains more field checks, the photographs should provide keys which will enable the mapper to accurately designate types which are similar even though he does not see each individual type on the ground. Some species may be quite accurately determined on the photo by the experienced man. However only after a man has developed experience and confidence will he be able to minimize field checking.

The field man is in an excellent position to expeditiously plan and undertake his work since the photographs show him the easiest routes to follow in order that he may see a maximum amount of territory in one day. An experienced man can save time by checking only the doubtful types and can choose the fastest travel route to reach those types.

The broad overlay made in the office will be used as a guide for the size of type areas so that most of the type boundaries will already be shown prior to field work. However, subtypes based on species or differences between commercial and non-commercial timber sites will be sketched on the species overlay in the field down to upper fixed minimum, i.e., not below 40 acres. The stereoscope may often be put to good field use in determining these boundaries.

In listing species symbols on the species overlay the order of elements as determined on the broad overlay should be followed. Thus in a CSH type all coniferous species should be listed first, shrubs second, and hardwood last. Within one type element the species should be listed in order of dominance. A possible symbol listing for species in the above example might be Y I Cc Av B W. The NT symbol should be shown on the species overlay for areas which are non-commercial timber site. If types must be subdivided because of differences between non-commercial and commercial timber site, show supplementary boundaries with dotted lines. All type areas not containingan NT symbol will be assumed to be commercial timberland.

Field outlining and symboling should be done in red pencil on the overlays and at intervals of not over a few days should be permanently inked in violet. NT symbols however should be shown in black ink and supplementary NT boundaries in dotted black ink lines.

Some field corrections in office interpretations of the photographs will be necessary especially where complicated types are involved. The field man should feel free to make erasures and corrections on the broad overlay where he has good reason to believe the office work is in error. However, the burden of proof is on the field mapper and he

should certify his judgment with more stereoscopic study if necessary before making such corrections. Where large areas are involved or determination is doubtful these cases should be brought to the attention of the field supervisor at the earliest opportunity.

A specific point regarding the field interpretation of mosaic types begs mention here. Since this mapping procedure aims to show natural and not artificial type classifications the case may arise in some regions where a strict obeyance with the 20% crown cover rule in designating mosaics by broad office interpretation might defeat the mapping objective and result in the grouping of strongly contrasting vegetation sites within one type designation. For example it might happen that the office interpreter decided to absorb several small shrub areas, because of insufficient size to be outlined separately, into a surrounding type of pure timber. When the shrub areas were thus absorbed into the timber type the interpreter estimated that, since the shrubs apparently formed 20% or more of the crown cover within the grouped type, the large timber block should now be designated as (CS) which would be in strict conformance with the instructions and would give a proper medium density rating for the conifers within the final type as outlined instead of a false well stocked rating as a (C) designation alone would indicate. This designation would then indicate that both conifer and shrub symbols should be entered to show the dominant species for this area in the field. If such species were found to be Ponderosa Pine and manzanita (Arctostaphylos viscida) by field check such species would logically be indicated by symbols as dominants for this type area and would in fact, since these species both indicate a timber site and often grow as associates, indicate a true natural vegetation association. However, suppose a field check reveals that the timber species within the outlined area is Redwood and the shrub species is Chamise. In strict conformance with the type map instructions a symbol for each of these species on the species overlay would be indicated. But Redwood and Chamise never, to the best of botanical knowledge, form a natural vegetation association. Therefore, although the broad overlay designation for the area might be left unchanged as (CS) to give the true picture of coniferous stocking, the species overlay might better exhibit a symbol for Redwood alone since the largest portion of the outlined area is a timber-growing site and not a non-timber-growing site as the chamise symbol would indicate. The foregoing gives but one example of unnatural vegetation formations. Other such questionable cases may arise with different type elements or species. These cases may be rare, but where the field mapper has good reason to feel that any type mosaic as outlined on the photograph is not truly a natural association, he should bring the case to the attention of his superior for interpretation.

Tie-ins of types on common photographic overlaps should be carefully made so that common boundaries match and no symbols are omitted - this all to be done by field men responsible for mapping the area.

R. C. Wilson
March 3, 1939.

UNITED STATES DEPARTMENT OF AGRICULTURE
Office of the Secretary
Office of Land Use Coordination
Washington

February 28, 1940.

MEMORANDUM NO. 63

MEMORANDUM TO FIELD FLOOD CONTROL COMMITTEES
(Through BAE, FS, and SCS)

Subject: Number of Flood Control Reports Required.

In an endeavor to expedite the review of Departmental flood control reports, it is requested that in the future, the following number of flood control reports be transmitted to the Washington office. These should be submitted through the regular Bureau channels as in the past.

Preliminary Examination Reports	8
Survey Work Outlines	8
Survey Reports	18

Very truly yours,

E. H. Wiecking

E. H. Wiecking,
Associate Land Use Coordinator,
In Charge, Flood Control Coordination.